R1 .16

1st term

2016- 2015

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نعمل لخدماتكم منذ عام2000

EL FARES

الفارس

Revision(1)

مادة hydraulics

الفرقة الثالثة مدني

للتواصل معنا

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العنوان : كوبري الجامعه _ اسفل قاعه علاء الدين

للتواصل علي الانترنت :

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State

- Forces affecting on flow in open channels:
- Types of open channels according to boundaries
- Steady and Unsteady flow
- Uniform and Non-uniform flow
- Gradually and rapidly varied flow
- Regime of flow
- Open channel flow and pipe flow
- Best hydraulic section
- State the factors affecting the Manning's roughness coefficient
- Tractive force
- Permissible tractive force
- Critical tractive force
- Critical shear stress
- Incipient motion
- Tractive force ratio
- Shear velocity
- Isovels
- List the main factors affecting the velocity distribution in open channels
- List the different methods for discharge measurements in open channels
- Dimensional analysis
- List advantage and disadvantage of dimensional analysis
- Modeling
- What is the importance of hydraulic modeling?
- State the advantages and disadvantages of hydraulic modeling
- Types of similarity
- Types of models
- Distorted model and undistorted model
- Types of distorted models
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- Two alternative depths
- Definitions of the critical depth by different methods
- Explain the effect of hump height on the two alternate depths in a rectangular channel, using neat sketches diagram

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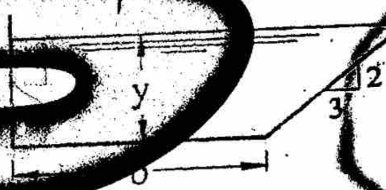
- Explain the effect of Depression on the two alternate depths in a rectangular channel, using neat sketches diagram
- Explain the effect of bed Contraction on the two alternate depths in a rectangular channel, using neat sketches diagram
- Explain the effect of bed Expansion on the two alternate depths in a rectangular channel, using neat sketches diagram
- Specific energy, specific discharge and specific force diagrams
- Hydraulic Jump
- Two conjugate depths
- Classification of Hydraulic Jump (According to Froude Number Fn1)
- Relation between conjugate depths of hydraulic jump in terms of Froude number
- Classify the water surface profiles according to the bed slope, give practical examples for each

Drive the following equations

- Drive the condition of best hydraulic section of rectangular section
- Drive the condition of best hydraulic section of trapezoidal section
- Drive the condition of best hydraulic section of triangular section
- Drive the condition of best hydraulic section of circular section
- The velocity distribution equation for laminar flow in open channel
- If V = 2.50U*Ln (30y/K) gives the velocity distribution in turbulent flow over rough height. Derive an expression for the mean velocity
- Show that the maximum velocity in a circular open channel of certain diameter takes place when the water depth is 0.81 times the channel diameter. Also show that the maximum discharge occurs when the water depth is 0.95 the diameter.
- Drive the expression for critical depth, critical specific energy and critical velocity in Rectangular section.
- Drive the expression for critical depth, critical specific energy and critical velocity in Non Rectangular section.
- Derive the relationship between the conjugate depths as a function of the critical depth.
- Derive the relationship between the conjugate depths as a function of the Froude's Number.

Final "2013"

A best h[illegible]ulic section having o[illegible]side is vertical, and the [illegible] is [illegible] at 3:2, [illegible]ries a disch[illegible] of $25 m^3/s$ w[illegible] $= 0.37 y^{0.64}$ wher[illegible] the water de[illegible]. Determine the ca[illegible] dimensions and bed slope if $1/n = 40$



Final "2012"

A trapezoidal channel carrying discharge of $20 m^3/sec$. The bed slope is 10 cm/km, one side is vertical and th[illegible]ope [illegible] and n = [illegible]5. Design the channel cross-section so that the section is of best hydraulic section, If the water kinematic viscosity is $1.[illegible]\times 10^{-6}$ [illegible]efine th[illegible]ing through this channel?

Final "2010"

A trapezoidal channel carrying discharge of $40 m^3/sec$. The bed slope is 10 cm/km, side slope is 1:1 and n = [illegible]025. De[illegible] the channel cross-section dimensions for the following two cases:

1) The maximum allow[illegible] is 0.50 m./sec.
2) The maximum allowable shear stress is 0.20 [illegible]
3) The section is of bes[illegible] hydr[illegible]ulic sec[illegible]on

If the water kinematic viscosity is $1.0\times 10^{[illegible]}$ [illegible]/sec, defin[illegible] the flow regime passing ~~through this channel f[illegible] each case?~~

Final "2013", "2015"

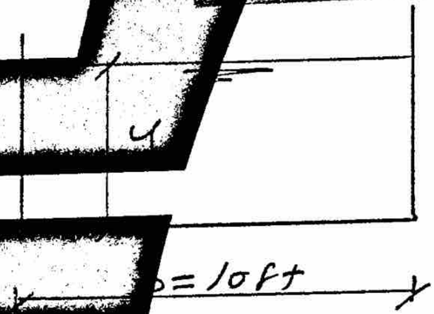
For a rectangular section of 10 ft bed width having [illegible] 200 c.f.s, the sides of the canal lined with concrete have Manning's coefficient of 0.014, the flow passes through canal with a F[illegible], find the Canal bed slope.

$b = 10\ ft$

$Q = 200\ ft^3/sec$

$n = 0.014$

$F = 2$



req: $S = ?$

solution

$$F = \frac{V}{\sqrt{gy}} \qquad V = \frac{Q}{A}$$

$$2 = \frac{200/(10*y)}{\sqrt{32.2\,y}} \Rightarrow \boxed{y = 1.46\ ft}$$

$$A = b\cdot y = 10 * 1.46 = 14.6\ ft^2$$

$$P = b + 2y = 10 + 2*1.46 = 12.92\ ft$$

$$Q = \frac{1.486}{n} * \frac{A^{5/3}}{P^{2/3}} * S^{1/2}$$

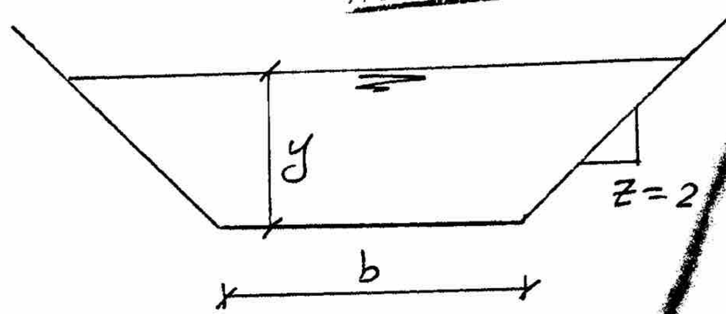
$$200 = \frac{1.486}{0.014} * \frac{(14.6)^{5/3}}{(12.92)^{2/3}} * S^{1/2}$$

$$\Rightarrow \boxed{S = 0.01415}$$

Final "2010"

Design stable trapezoidal section to carry $Q=20\ m^3/s$, if the channel side slope is 2, longitudinal slope is 12 cm/km. If $d_{50}=3.0$ mm, $n=0.015$, $\phi=30^0$, $\gamma_s=2.65\ t/m^3$.

$Q = 20\ m^3/sec$



$Z = 2$

$S' = 12\ cm/km$

$d_{50} = 3\ mm$

$n = 0.015$

req:- Design $b = ?$, $y = ?$

solution

$d_{50} = 3\ mm = 0.3\ cm \Rightarrow \tau_{av} = 0.3\ kg/m^2$

$\tau_{av} = \gamma \cdot R \cdot S$

$0.3 = 1000 * R * (12 * 10^{-5}) \Rightarrow \boxed{R = 2.5}$

$$V = \frac{1}{n} * R^{\frac{2}{3}} * S^{\frac{1}{2}}$$

$$= \frac{1}{0.015} * (2.5)^{\frac{2}{3}} * (12 * 10^{-5})^{\frac{1}{2}}$$

$= 1.35\ m/sec$

$$\Rightarrow A = \frac{Q}{V} = \frac{20}{1.35} = 14.8 \text{ m}$$

$$\Rightarrow R = \frac{A}{P}$$

$$2.5 = \frac{14.8}{P} \Rightarrow \boxed{P = 5.92}$$

$$\Rightarrow P = b + 2y\sqrt{1+z^2}$$

$$5.92 = b + 2y\sqrt{1+(2)^2}$$

$$5.92 = b + 4.47y$$

$$\boxed{b = 5.92 - 4.47y}$$

$$\Rightarrow A = y(b + zy)$$

$$14.8 = y(5.92 - 4.47y + 2y)$$

$$14.8 = 5.92y - 2.47y^2$$

$$2.47y^2 - 5.92y + 14.8 = 0$$

by solving eqn

$b =$

Mid - Term "2015"

C) Design of a trapezoidal section of side slope 2:1, n= 0.025, bed slope 10 cm/km, carrying discharge equal 60 m^3/s for the following cases.

- The most efficient section
- Non erodible section (d_{50}=4mm)

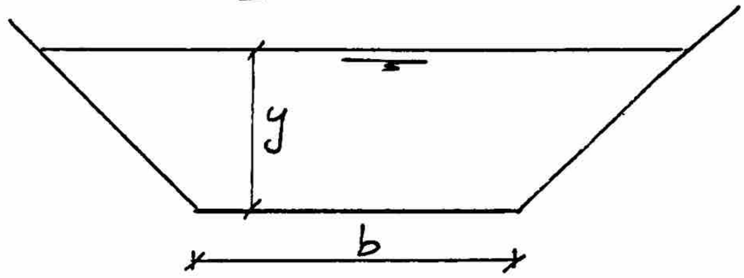
$Z = 2$

$n = 0.025$

$S = 10$ Cm/km

$Q = 60\ m^3/sec$

$d_{50} = 4$ mm



req:- Design section $b = ?$, $y = ?$

1) B.H.S

2) Non erodible section

solution

$Z=2$

1) For B.H.S $\Rightarrow$ $R = \frac{y}{2}$, $\cancel{Z = \frac{1}{\sqrt{3}}}$

$\Rightarrow A = y(b + Zy)$

$= y(b + 2y)$

$\Rightarrow P = b + 2y\sqrt{1+Z^2}$

$= b + 2y\sqrt{1+(2)^2}$

$= b + 4.47y$

$$R = \frac{A}{P} = \frac{y}{2}$$

$$\frac{y(b+2y)}{b+4.47y} = \frac{y}{2}$$

$$2b + 4y = b + 4.47y \Rightarrow \boxed{b = 0.47y}$$

$$\Rightarrow A = y(b+2y)$$

$$= y(0.47y + 2y)$$

$$= 2.47\, y^2$$

$$\Rightarrow P = b + 4.47y$$

$$= 0.47y + 4.47y$$

$$= 4.94y$$

$$Q = \frac{1}{n} * \frac{A^{5/3}}{P^{2/3}} * S^{1/2}$$

$$60 = \frac{1}{0.025} * \frac{(2.47y^2)^{5/3}}{(4.94y)^{2/3}} * (10*10^{-5})^{1/2}$$

by solving eqn $\rightarrow$ $\boxed{y = 5.55}$

$\boxed{b = 2.61\ m}$

2) non erodible section

$\Rightarrow d_{50} = 4\ mm = 0.4\ cm \Rightarrow \boxed{\tau_{av} = 0.4\ kg/m^2}$

$\Rightarrow \tau_{av} = \gamma \cdot R \cdot S$

$0.4 = 1000 * R * (10*10^{-5}) \Rightarrow \boxed{R = 4}$

$\Rightarrow V = \frac{1}{n} * R^{2/3} * S^{1/2}$

$= \frac{1}{0.025} * (4)^{2/3} * (10*10^{-5})^{1/2} = 1\ m/sec$

$\Rightarrow Q = A \cdot V$

$60 = A * 1 \Rightarrow \boxed{A = 60\ m^2}$

$\Rightarrow R = \frac{A}{P}$

$4 = \frac{60}{P} \Rightarrow \boxed{P = 15\ m}$

$\Rightarrow P = b + 2y\sqrt{1+Z^2}$

$15 = b + 2y\sqrt{1+(2)^2}$

$15 = b + 4.47y$

$\boxed{b = 15 - 4.47y}$

$$A = y(b + Zy)$$

$$60 = y(15 - 4.47y + 2y)$$

$$60 = 15y - 2.47y^2$$

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$$2.47y^2 - 15y + 60 = 0$$

by solving eqn. $\Rightarrow$ $y = \checkmark$

$b = \checkmark$

Mid-Term "2015"

C) the following equation is the equation of velocity distribution in a channel

$$V = 1.8\left(\frac{y}{y_o}\right) - \left(\frac{y}{y_o}\right)^2$$

Where y measured from bed and y_o the total depth equal = 2.0m Determine the following requirement

- Bed velocity
- Mean velocity
- Maximum velocity
- Unit discharge

$$V = 1.8\left(\frac{y}{y_o}\right) - \left(\frac{y}{y_o}\right)^2 \quad , \quad y_o = 2.0\ m$$

$$V = 1.8\left(\frac{y}{2}\right) - \left(\frac{y}{2}\right)^2$$

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$$\boxed{V = 0.9\,y - 0.25\,y^2}$$

1) Bed Velocity at $y = 0$

$$V = 0.9 * (0) - 0.25 * (0)^2 = \text{Zero}$$

2) Mean Velocity "V_m"

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مساحة المستطيل = المساحة تحت المنحنى

$$V_m * y_o = \int_0^{y_o} V\,dy$$

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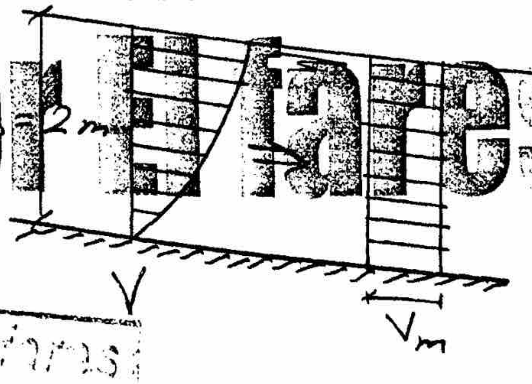

$$V_m = \frac{1}{y_o}\int_0^{y_o} V\,dy$$

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$$\boxed{V = 0.9\,y - 0.25\,y^2}$$

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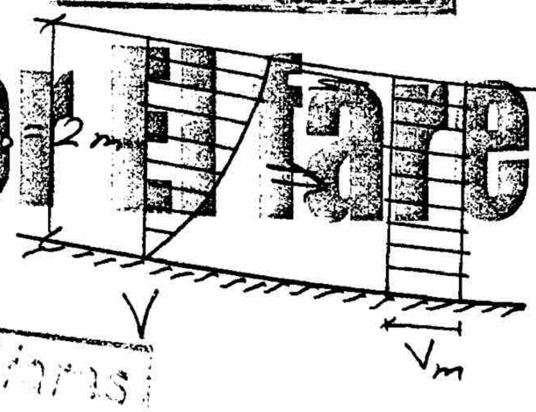
$$V_m * y_o = \int_0^{y_o} V\,dy$$



$$V_m = \frac{1}{y_o}\int_0^{y_o} V \cdot dy$$

$$V_m = \frac{1}{2}\int_0^2 (0.9\,y - 0.25\,y^2)\cdot dy$$

$$= \frac{1}{2}\left(0.9\,\frac{y^2}{2} - 0.25\,\frac{y^3}{3}\right)_0^2$$

$$= 0.57 \;\; m/sec$$

3) Maximum Velocity "V_{max}"

$$\frac{dV}{dy} = 0$$

$$0 = 0.9 - 0.5\,y \Rightarrow \boxed{y = 1.8\ m}$$

V_{max} at $y = 1.8\ m$

$$V_{max} = 0.9 * 1.8 - 0.25 * (1.8)^2 = 0.81\ m/sec$$

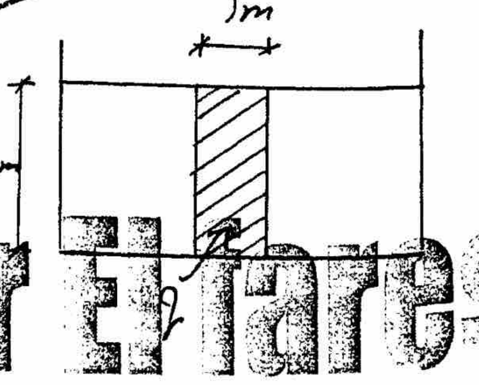
4) Unit discharge "q"

$$q = V_m \cdot A$$

$$= V_m * (y_o * 1)$$

$$= 0.57 * (2)$$

$$= 1.14\ m^3/sec/m$$



Mid - Term "2015"

Calculate the discharge over a sharp crested weir 5.0 m long if the head of water over the crest is 0.40 m. take Cd=0.62

$b = 5.0\ m$

$H = 0.4\ m$

$C_d = 0.62$

req:- $Q = ?$

solution

$$Q = \frac{2}{3} C_d \cdot b \cdot \sqrt{2g}\ H^{1.5}$$

$$= \frac{2}{3} * 0.62 * 5 * \sqrt{2*9.81} * (0.4)^{1.5}$$

$$= 2.3\ m^3/sec$$

Final "2010"

Calculate the model velocity for open channel if length scale of 1/10 and prototype velocity is 3m/s

$L_r = \frac{1}{10}$

$V_p = 3 \ m/sec$

req:- $V_m = ?$

solution

$$V_r = \frac{L_r}{T_r} = \frac{L_r}{L_r^{1/2}} = L_r^{1/2}$$

$$V_r = \frac{V_m}{V_p} = L_r^{1/2}$$

$$\frac{V_m}{3} = \left(\frac{1}{10}\right)^{1/2} \Rightarrow \boxed{V_m = 0.95 \ m/sec}$$

Mid - Term "2015"

A dam 15 m has a discharge rate Q= 100 m^3/s, under a head of 3.0 m. design the model, if the supply available in the laboratory is 40 liters/sec

$L_p = 15\ m$

$Q_p = 100\ m^3/sec$

$H_p = 3.0\ m$

$Q_m = 40\ L/sec = 0.04\ m^3/sec$

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req: L_m, H_m

solution

$$Q_r = \frac{L_r^3}{T_r} = \frac{L_r^3}{L_r^{1/2}} = L_r^{2.5}$$

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$$Q_r = \frac{Q_m}{Q_p} = L_r^{2.5}$$

$$\frac{0.04}{100} = L_r^{2.5} \Rightarrow \boxed{L_r = 0.0437}$$

$$\Rightarrow L_r = \frac{L_m}{L_p} = L_r$$

$$\frac{L_m}{15} = 0.0437 \Rightarrow \boxed{L_m = 0.66\ m}$$

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$$H_r = \frac{H_m}{H_p} = L_r$$

$$\frac{H_m}{3} = 0.0437 \Rightarrow \boxed{H_m = 0.13\ m}$$

Final "2012"

A rectangular channel 2.5m wide has a specific energy of 1.5m when carrying a discharge of 6.48m³/s. Calculate the water depths and the corresponding Froude numbers

$b = 2.5\ m$

$E = 1.5\ m$

$Q = 6.48\ m^3/sec$

req:- y , F_r

solution

$$E = y + \frac{V^2}{2g} = y + \frac{Q^2}{2gA^2}$$

$$1.5 = y + \frac{(6.48)^2}{2 * 9.81 * (2.5 * y)^2}$$

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by solving equ. $\Longrightarrow$ $\boxed{y_1 = 0.63\ m}$

$\boxed{y_2 = 1.3\ m}$

$$F_{r1} = \frac{V_1}{\sqrt{g y_1}}$$

$$= \frac{6.48 / (2.5 * 0.63)}{\sqrt{9.81 * 0.63}} = 1.65$$

$$F_{r2} = \frac{V_2}{\sqrt{g y_2}}$$

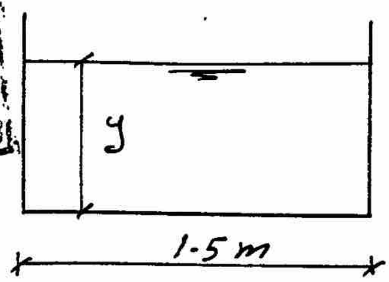
$$= \frac{6.48 / (2.5 * 1.3)}{\sqrt{9.81 * 1.3}} = 0.56$$

Final "2012"

For constant specific energy of 1.50m what is the maximum flow that may occur in rectangular open channel of 1.50 m width?

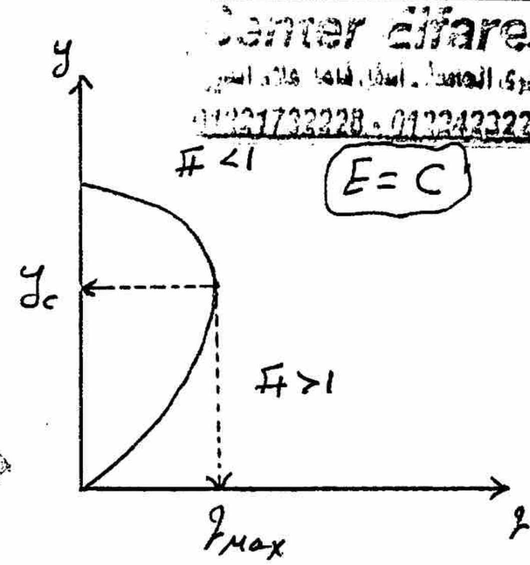
$E = 1.5\ m$

$b = 1.5\ m$



Req:- $Q_{max} = ?$

solution



الطاقة ثابتة $E_{min} = 1.5\ y_c$

$1.5 = 1.5\ y_c$

$y_c = 1.0\ m$

$$y_c = \sqrt[3]{\frac{q_{max}^2}{g}}$$

$$1.0 = \sqrt[3]{\frac{q_{max}^2}{9.81}} \Rightarrow q_{max} = 3.13\ m^3/sec/m$$

$Q_{max} = q_{max} \cdot b$

$= 3.13 * 1.5 = 4.7\ m^3/sec$

Final "2008"

A 3.0 m wide rectangular channel carries 2.4 cubic meter per second discharge at a depth of 0.7 m. Do the following:

(a) Determine specific energy at 0.7 m depth.

(b) Determine the critical depth.

(c) Is the flow subcritical or supercritical?

(d) Determine the depth alternate to 0.7 m.

(e) If Manning's n is 0.015, determine the critical slope.

$b = 3.0 \text{ m}$

$Q = 2.4 \text{ m}^3/\text{sec}$

$y = 0.7 \text{ m}$

solution

a)

$$V = \frac{Q}{A} = \frac{2.4}{3 * 0.7} = 1.14 \text{ m/sec}$$

$$E = y + \frac{V^2}{2g}$$

$$= 0.7 + \frac{(1.14)^2}{2 * 9.81} = 0.77 \text{ m}$$

b)

$$q = \frac{Q}{b} = \frac{2.4}{3} = 0.8 \text{ m}^3/\text{sec/m}$$

$$y_c = \sqrt[3]{\frac{q^2}{g}} = \sqrt[3]{\frac{(0.8)^2}{9.81}} = 0.4 \text{ m}$$

c) $y_n > y_c \Rightarrow$ sub critical flow

d)

$$E = y + \frac{V^2}{2g}$$

$$0.77 = y + \frac{(2.4/(3*y))^2}{2*9.81}$$

by solving eqn $\Longrightarrow$ $y = 0.25\ m$

e)

$S_c \Longrightarrow y_n = y_c = 0.4\ m$

$$A = b \cdot y_c = 3*0.4 = 1.2\ m$$

$$P = b + 2y = 3 + 2*0.4 = 3.8\ m$$

$$Q = \frac{1}{n} * \frac{A^{\frac{5}{3}}}{P^{\frac{2}{3}}} * S_c^{\frac{1}{2}}$$

$$2.4 = \frac{1}{0.015} * \frac{(1.2)^{\frac{5}{3}}}{(3.8)^{\frac{2}{3}}} * S_c^{\frac{1}{2}}$$

$S_c = 0.0042$

Final "2013"

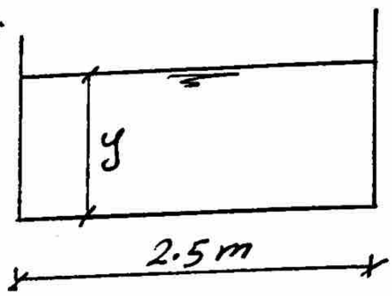
A rectangular channel 2.5m wide carries discharge of $6 m^3/sec$ at a depth of 0.5m. **Calculate the height of a flat topped hump** required to be placed at a section to cause critical flow. The energy loss due to the obstruction by the hump can be taken as 0.1 times the upstream velocity head.

$b = 2.5\ m$

$Q = 6\ m^3/sec$

$y_1 = 0.5\ m$

$h_L = 0.1 \dfrac{V_1^2}{2g}$



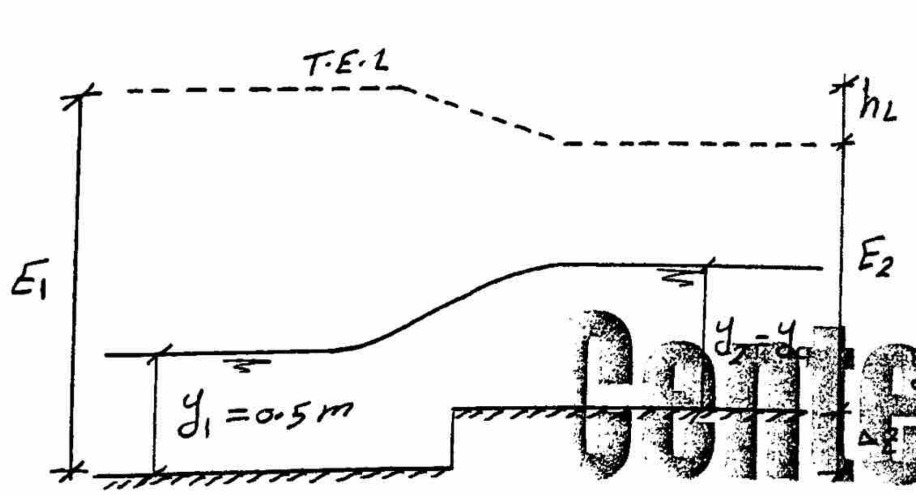
req:- $\Delta Z = ?$ $\Rightarrow$ $y_2 = y_c$

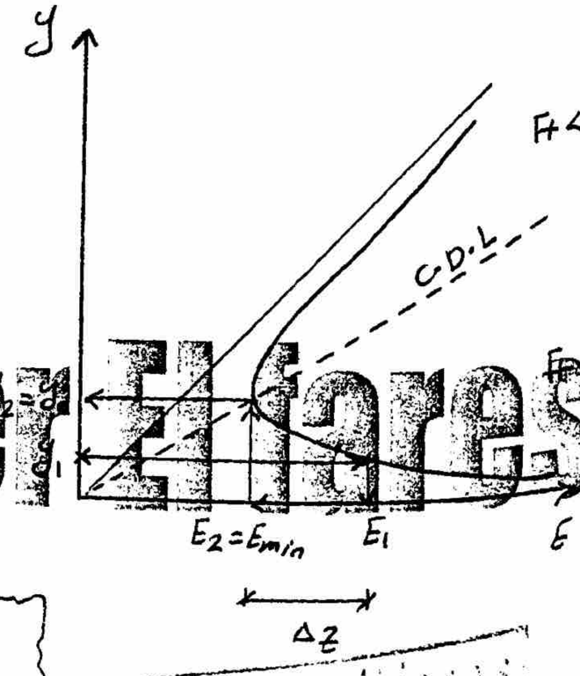
solution

$$V_1 = \frac{Q}{A_1} = \frac{6}{2.5 * 0.5} = 4.8\ m/sec$$

$$F_1 = \frac{V_1}{\sqrt{g\,y_1}} = \frac{4.8}{\sqrt{9.81 * 0.5}} = 2.17 > 1$$

super critical flow





$$\boxed{E_1 = E_2 + \Delta Z + h_L}$$

$$E_1 = y_1 + \frac{V_1^2}{2g}$$

$$= 0.5 + \frac{(4.8)^2}{2 * 9.81} = 1.67$$

$$E_2 = E_{min} = 1.5\, y_c$$

$$y_c = \sqrt[3]{\frac{q^2}{g}} = \sqrt[3]{\frac{(6/2.5)^2}{9.81}} = 0.84$$

$$E_2 = 1.5 * 0.84 = 1.26$$

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$$h_L = 0.1 * \frac{V_1^2}{2g}$$

$$= 0.1 * \frac{(4.8)^2}{2*9.81} = 0.12$$

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$$E_1 = E_2 + \Delta Z + h_L$$

$$1.67 = 1.26 + \Delta Z + 0.12$$

$$\Delta Z = 0.29\,m$$

Center El fares

Center Elfares

Final "2010" , "2011"

4.0 m wide rectangular section carries a discharge of 16 m^3/s at depth of 1.50 m

- What will be the depth over a hump of 0.30 m
- Find the difference in water levels before and after the hump
- What will you do to maintain the water level unchanged
- Draw the relation between the two alternative depths and the hump height

$b = 4.0\ m$

$Q = 16\ m^3/sec$

$y_1 = 1.5\ m$

req :- 1) $\Delta Z = 0.3 \uparrow \Rightarrow y_2 = ?$

2) $\Delta y = ?$

3) ما هو الحل الذى يجعل سطح الماء ثابت مع وجود العتبة

4) Draw the relation $y_1 , y_2 , \Delta Z$

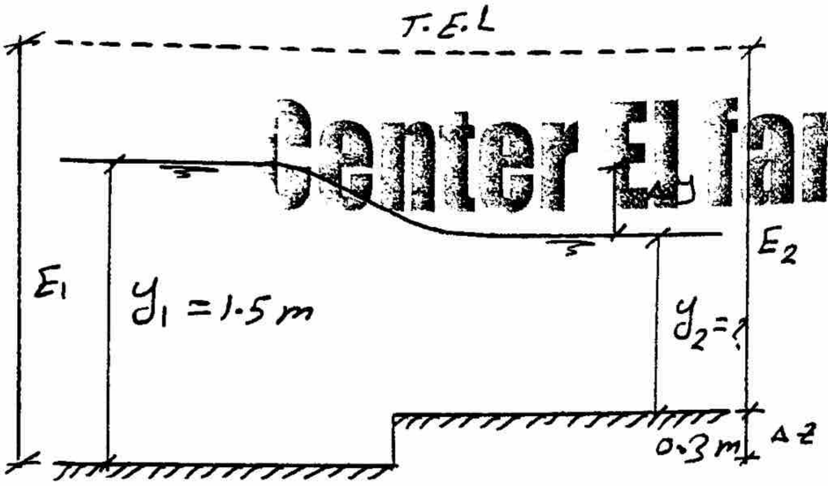
solution

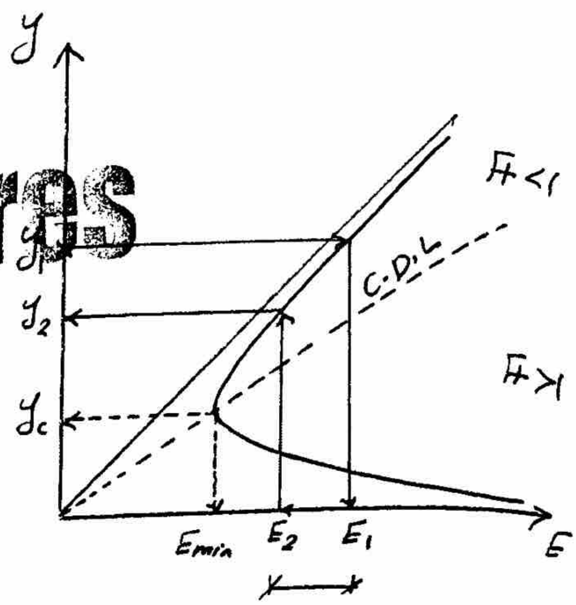
$$V_1 = \frac{Q}{A_1} = \frac{16}{4 * 1.5} = 2.67\ m/sec$$

$$F_1 = \frac{V_1}{\sqrt{g y_1}}$$

$$= \frac{2.67}{\sqrt{9.81 * 1.5}} = 0.7 < 1$$

sub critical flow





$$E_1 = E_2 + \Delta Z$$

$$y_1 + \frac{V_1^2}{2g} = y_2 + \frac{V_2^2}{2g} + \Delta Z$$

$$1.5 + \frac{(2.67)^2}{2 * 9.81} = y_2 + \frac{(16/(4 * y_2))^2}{2 * 9.81} + 0.3$$

by solving eqn. $\Longrightarrow$ $y_2 = -0.61\,m$

⇐ y_2 قيمة سالبه وهذا لا يمكن أن يحدث

⇐ ولكن مع زيادة ارتفاع العتبه حدث نقص لـ y_2 الى ان وصلت لـ y_c

⇐ ... قيمة ... غير معلومه

$$y_c = \sqrt[3]{\frac{q^2}{g}} = \sqrt[3]{\frac{(16/4)^2}{9.81}} = 1.18\,m$$

$\boxed{y_2 = y_c = 1.18\ m}$, $y_1 = ?$

$E_1 = E_2 + \Delta Z$

$$y_1 + \frac{V_1^2}{2g} = y_2 + \frac{V_2^2}{2g} + \Delta Z$$

$$y_1 + \frac{(16/(4y_1))^2}{2*9.81} = 1.18 + \frac{(16/(4*1.18))^2}{2*9.81} + 0.3$$

by solving eqn.

$y_1 = \{-0.56 , 0.8 , 1.82\}$ $\quad y_1 > y_c$

$\boxed{y_1 = 1.82\ m}$

---

2) $y_1 = y_2 + \Delta Z + \Delta y$

$1.82 = 1.18 + 0.3 + \Delta y$

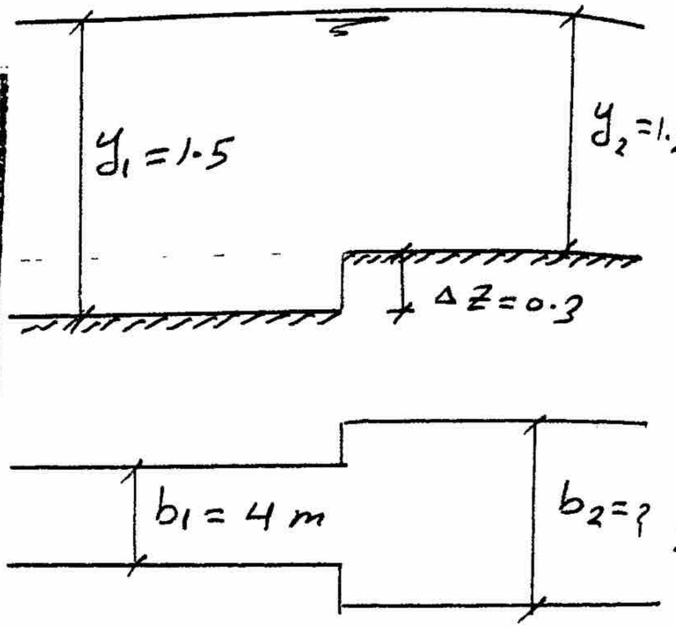
$\boxed{\Delta y = 0.34\ m}$

3)

$\Leftarrow$ ما هو الحل الذى يجعل سطح الماء ثابت

$\Leftarrow$ يتم عمل اتساع فوق العتبه حتى يزداد سطح الماء بمقدار يعوض النقص نتيجه وجود العتبه

$$\boxed{y_1 = 1.5\ m}$$



$$y_1 = y_2 + \Delta z$$

$$1.5 = y_2 + 0.3$$

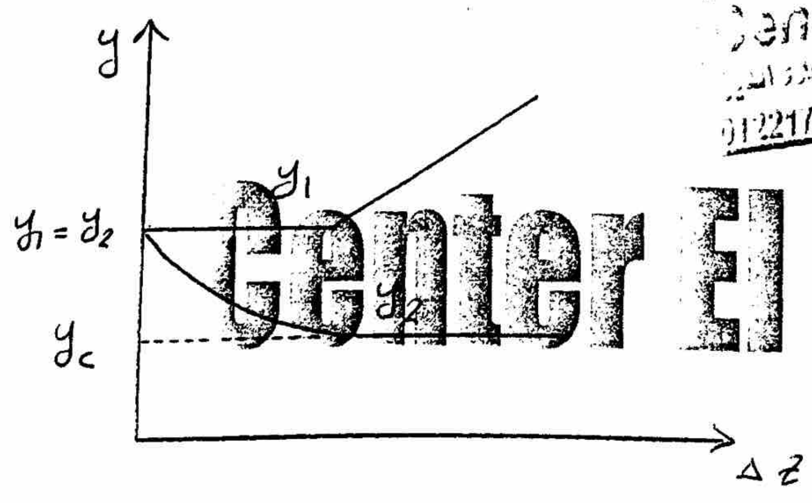
$$\boxed{y_2 = 1.2\ m}$$

$$E_1 = E_2 + \Delta z$$

$$1.5 + \frac{(16/(4*1.5))^2}{2*9.81} = 1.2 + \frac{(16/(b_2*1.2))^2}{2*9.81} + 0.3$$

by solving eqn. $\Longrightarrow$ $\boxed{b_2 = 5.0\ m}$

4)



Final "2013"

A hydraulic jump is formed in a horizontal open channel of trapezoidal section, the bed width is 10m and the side slope is 2:1, the two conjugate depths are 2.0, 5.0m. Calculate:

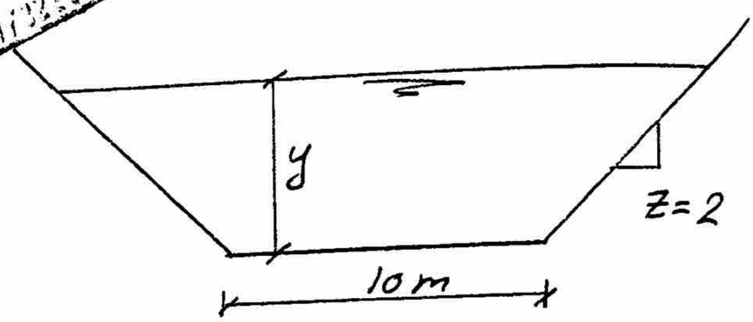
- **The discharge,**
- **Power dissipated in HP,**
- **The relative loss and**
- **The efficiency of jump.**

$b = 10 \ m$

$z = 2$

$y_1 = 2.0 \ m$

$y_2 = 5.0 \ m$



req :-

1) $Q = ?$

2) power h_L

3) $\frac{h_L}{E_1}$

4) $\eta = \frac{E_2}{E_1}$

1)

$$\boxed{A_1 \bar{y}_1 + \frac{Q^2}{g A_1} = A_2 \bar{y}_2 + \frac{Q^2}{g A_2}}$$

المعادله العامة
لإنزاح
ر Jump

$$A_1 = y_1 (b + z y_1)$$

$$= 2 * (10 + 2 * 2) = 28 \ m^2$$

$$A_2 = y_2 (b + z y_2)$$

$$= 5 * (10 + 2 * 5) = 100 \ m^2$$

$$A_1 \bar{y}_1 = \frac{b \cdot y_1^2}{2} + \frac{z \cdot y_1^3}{3}$$

$$= \frac{10 * (2)^2}{2} + \frac{2 * (2)^3}{3} = 25.33$$

$$A_2 \bar{y}_2 = \frac{b \cdot y_2^2}{2} + \frac{z \, y_2^3}{3}$$

$$= \frac{10 * (5)^2}{2} + \frac{2 * (5)^3}{3} = 208.33$$

$$25.33 + \frac{Q^2}{9.81 * 28} = 208.33 + \frac{Q^2}{9.81 * 100}$$

by solving eqn $\Rightarrow$ $Q = 264.2 \ m^3/sec$

2)

$$E_1 = y_1 + \frac{Q^2}{2g A_1^2}$$

$$= 2 + \frac{(264.2)^2}{2 * 9.81 * (28)^2} = 6.54 \ m$$

$$E_2 = y_2 + \frac{Q^2}{2g A_2^2}$$

$$= 5 + \frac{(264.2)^2}{2 * 9.81 * (100)^2} = 5.36 \ m$$

$$h_L = E_1 - E_2$$

$$= 6.54 - 5.36 = 1.18 \ m$$

$$\text{Power} = \frac{\gamma \cdot Q \cdot h_L}{75}$$

$$= \frac{1000 * 264.2 * 1.18}{75} = 4156.7 \ hp$$

3)

$$\frac{h_L}{E_1} = \frac{1.18}{6.54} = 0.18$$

4)

$$\eta = \frac{E_2}{E_1} * 100 = \frac{5.36}{6.54} * 100 = 82\%$$

Final "2012"

A rectangular basin has a discharge of 10 $m^3/s/m$ passes at depth of 0.8 m. Find

- The sequent depth,
- Relative loss,
- Estimate the jump length, Jump efficiency.

B-If an obstruction is placed in the bed to dissipate some energy, reducing the depth D.S. the jump to 3.7 m. What is the force on the obstruction?

$q = 10 \ m^3/sec/m'$

$y_1 = 0.8 \ m$

req :-

A) 1) $y_2 = ?$

2) $\frac{h_L}{E_1} = ?$

3) $L_J \ , \ \eta$

B) $F = ?$ $\rightarrow$ $y_2 = 3.7 \ m$

A) 1)

$$q = V_1 \cdot y_1$$

$$10 = V_1 * 0.8 \rightarrow \boxed{V_1 = 12.5 \ m/sec}$$

$$F_1 = \frac{V_1}{\sqrt{g y_1}}$$

$$= \frac{12.5}{\sqrt{9.81 * 0.8}} = 4.46$$

$$\frac{y_2}{y_1} = 0.5 \left(\sqrt{1 + 8 F_1^2} - 1\right)$$

$$\frac{y_2}{0.8} = 0.5 * \left(\sqrt{1 + 8 * (4.46)^2} - 1\right)$$

$$\boxed{y_2 = 4.66 \ m}$$

---

2)

$$E_1 = y_1 + \frac{q^2}{2g y_1^2}$$

$$= 0.8 + \frac{(10)^2}{2 * 9.81 * (0.8)^2} = 8.76 \ m$$

$$E_2 = y_2 + \frac{q^2}{2g y_2^2}$$

$$= 4.66 + \frac{(10)^2}{2 * 9.81 * (4.66)^2} = 4.89 \ m$$

$h_L = E_1 - E_2$

$= 8.76 - 4.89$

$= 3.87\ m$

$\frac{h_L}{E_1} = \frac{3.87}{8.76} \doteq 0.44$

3)

$L_J = 5.2\ y_2$

$= 5.2 * 4.66$

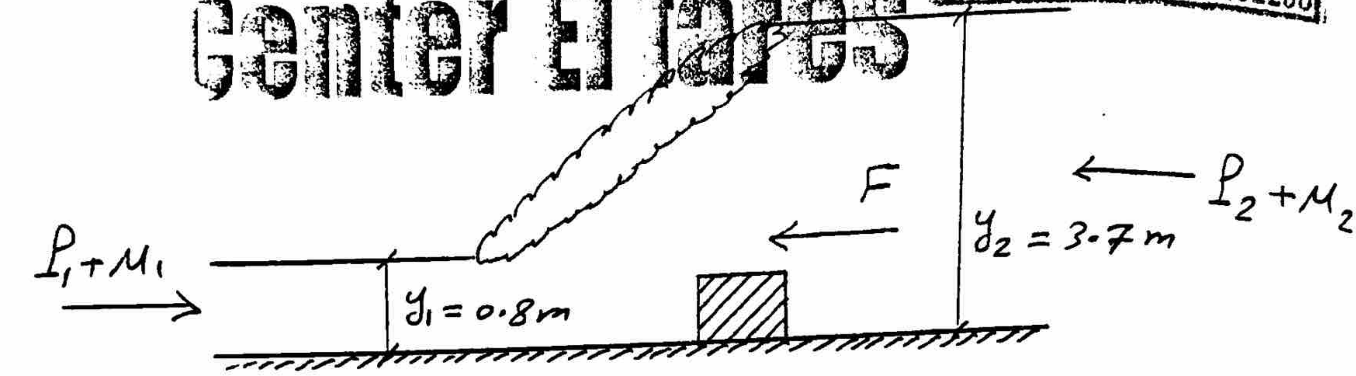
$= 24.23\ m$

$\eta = \frac{E_2}{E_1} * 100$

$= \frac{4.89}{8.76} * 100$

$= 55.8\ \%$

B)



$$P_1 + M_1 = P_2 + M_2 + F$$

$$\gamma \cdot A_1 \grave{y}_1 + \gamma \frac{Q^2}{g A_1} = \gamma \cdot A_2 \grave{y}_2 + \gamma \frac{Q^2}{g A_2} + F$$

take $b = 1.0 m$

$$A_1 = b \cdot y_1 = 1 * 0.8 = 0.8 \ m^2$$

$$A_2 = b \cdot y_2 = 1 * 3.7 = 3.7 \ m^2$$

$$A_1 \grave{y}_1 = \frac{b \cdot y_1^2}{2} = \frac{1 * (0.8)^2}{2} = 0.32$$

$$A_2 \grave{y}_2 = \frac{b \cdot y_2^2}{2} = \frac{1 * (3.7)^2}{2} = 6.845$$

$$1 * 0.32 + 1 * \frac{(10*1)^2}{9.81 * 0.8} = 1 * 6.845 + 1 * \frac{(10*1)^2}{9.81 * 3.7} + F$$

$$F = 3.46 \ t/m'$$

A hydraulic jump is formed in a horizontal open channel of rectangular section, the bed width 5.0 m and the jump height 11.56 m, and the corresponding Froude number is 6.5 at the initial water depth. Calculate the Froude number at the sequent depth, estimate the jump efficiency, the relative energy loss, and the jump length.

$b = 5.0\ m$

$H_J = 11.56\ m$

$F_1 = 6.5$

<u>req:-</u> F_2 , η , $\frac{h_L}{E_1}$, L_J

<u>solution</u>

$$\frac{y_2}{y_1} = 0.5\left(\sqrt{1+8F_1^2}-1\right)$$

$$\frac{y_2}{y_1} = 0.5 * \left(\sqrt{1+8*(6.5)^2}-1\right)$$

$$\boxed{y_2 = 8.7\ y_1}$$

$$H_J = y_2 - y_1$$

$$11.56 = 8.7\ y_1 - y_1 \rightarrow \boxed{y_1 = 1.5\ m}$$

$$\boxed{y_2 = 13\ m}$$

$$\frac{y_1}{y_2} = 0.5\left(\sqrt{1+8F_2^2}-1\right)$$

$$\frac{1.5}{13} = 0.5\left(\sqrt{1+8F_2^2}-1\right)$$

$$\boxed{F_2 = 0.25}$$

$$F_1 = \frac{V_1}{\sqrt{g y_1}}$$

$$6.5 = \frac{V_1}{\sqrt{9.81 * 1.5}} \Rightarrow \boxed{V_1 = 24.9 \ m/sec}$$

$$F_2 = \frac{V_2}{\sqrt{g y_2}}$$

$$0.25 = \frac{V_2}{\sqrt{9.81 * 13}} \Rightarrow \boxed{V_2 = 2.8 \ m/sec}$$

$$E_1 = y_1 + \frac{V_1^2}{2g}$$

$$= 1.5 + \frac{(24.9)^2}{2 * 9.81} = 33.1$$

$$E_2 = y_2 + \frac{V_2^2}{2g}$$

$$= 13 + \frac{(2.8)^2}{2 * 9.81} = 13.4$$

$$\eta = \frac{E_2}{E_1} * 100$$

$$= \frac{13.4}{33.1} * 100 = 40.5\%$$

$$h_L = E_1 - E_2$$

$$= 33.1 - 13.4$$

$$= 19.7$$

$$\frac{h_L}{E_1} = \frac{19.7}{33.1} = 0.6$$

$$L_J = 5.2\, y_2$$

$$= 5.2 * 13$$

$$= 67.6 \text{ m}$$

Final "2015"

Hydraulic jump was created in rectangular open channel with a bed with of 5.0 m, the jump height was found to be 11.0 m with initial Froude number 6.5. It is required to,

i- Find Froude number at sequent depth of hydraulic jump.

ii- Estimate the losses in kinetic energy through the jump,

$b = 5.0\ m$

$H_J = 11.0\ m$

$F_1 = 6.5$

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req.:- 1) $F_2 = ?$

2) Losses in Kinetic energy

solution

Center Elfares
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1)

$$\frac{y_2}{y_1} = 0.5\left(\sqrt{1+8F_1^2} - 1\right)$$

$$\frac{y_2}{y_1} = 0.5\left(\sqrt{1+8*(6.5)^2} - 1\right)$$

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$$y_2 = 8.7\, y_1$$

Center El fares

$$H_J = y_2 - y_1$$

$$11 = 8.7 y_1 - y_1 \rightarrow y_1 = 1.43\ m$$

$$y_2 = 12.4\ m$$

$$\frac{y_1}{y_2} = 0.5\left(\sqrt{1+8F_2^2} - 1\right)$$

$$\frac{1.43}{12.4} = 0.5\left(\sqrt{1+8F_2^2} - 1\right) \Rightarrow \boxed{F_2 = 0.25}$$

2)

$$E = y + \frac{V^2}{2g}$$

potential energy (y) — kinetic energy ($\frac{V^2}{2g}$)

$$h_L = \frac{V_1^2}{2g} - \frac{V_2^2}{2g}$$

$$F_1 = \frac{V_1}{\sqrt{g y_1}}$$

$$6.5 = \frac{V_1}{\sqrt{9.81 * 1.43}} \Rightarrow \boxed{V_1 = 24.3 \text{ m/sec}}$$

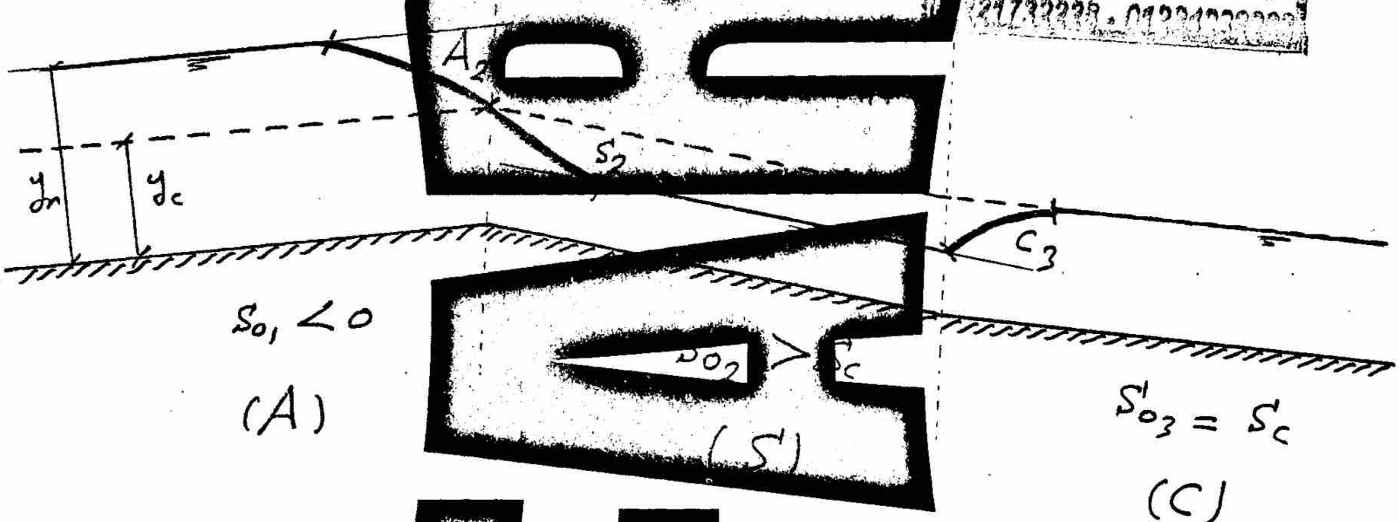
$$F_2 = \frac{V_2}{\sqrt{g y_2}}$$

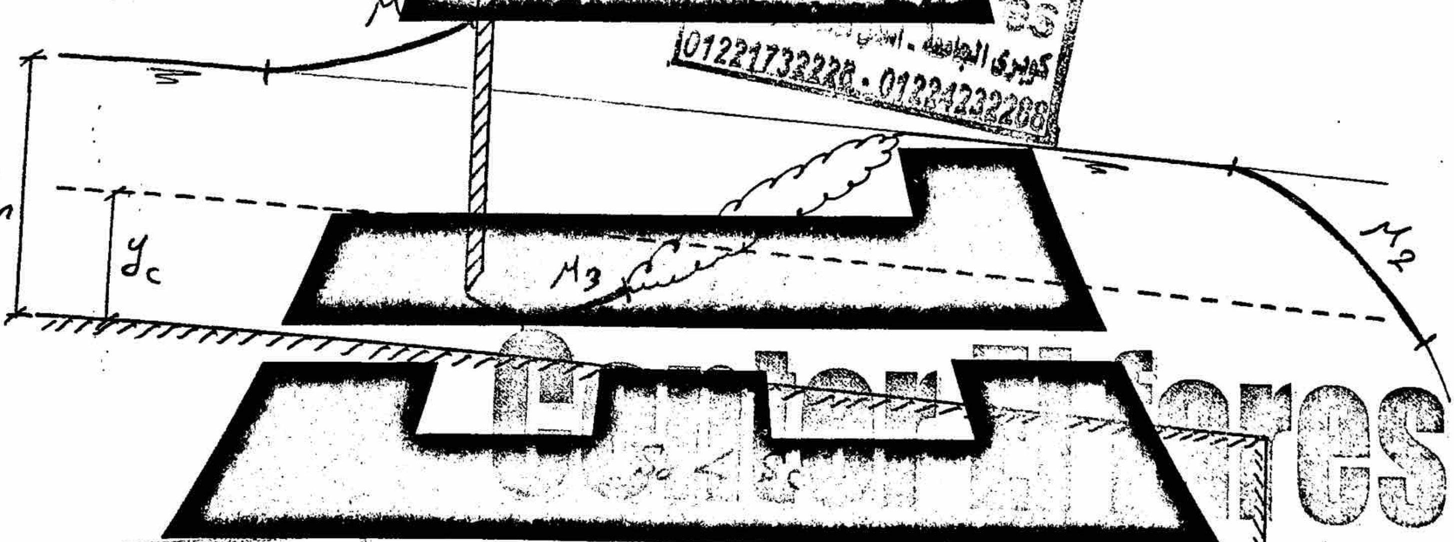
$$0.25 = \frac{V_2}{\sqrt{9.81 * 12.4}} \Rightarrow \boxed{V_2 = 2.76 \text{ m/sec}}$$

$$h_L = \frac{(24.3)^2}{2*9.81} - \frac{(2.76)^2}{2*9.81} = 29.7 \text{ m}$$

Final "2013"

C- Sk[illegible] face profile for follow[illegible]





Center Elfares
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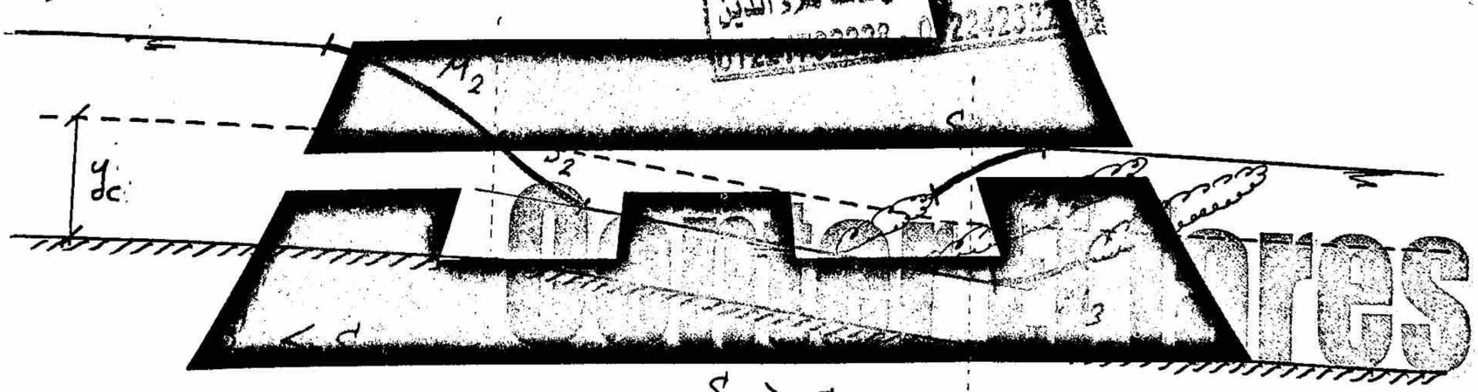
Final "2012"

Sketch [illegible] file if the bed slope changed from Adverse to steep to critical.

Sketch the water surface profile for each of the following bed slopes,

1) the bed slope $S_o < S_c$ to $S_o > S_c$ to $S_o < S_c$
2) the bed slope $S_o = 0$ to $S_o < S_c$ to $S_o > S_c$
3) the bed slope $S_o > S_c$ to S_o [illegible] S_c to $S_o > S_c$
4) the bed slope $S_o < S_c$ to $S_o = 0$ to $S_o > S_c$

1)

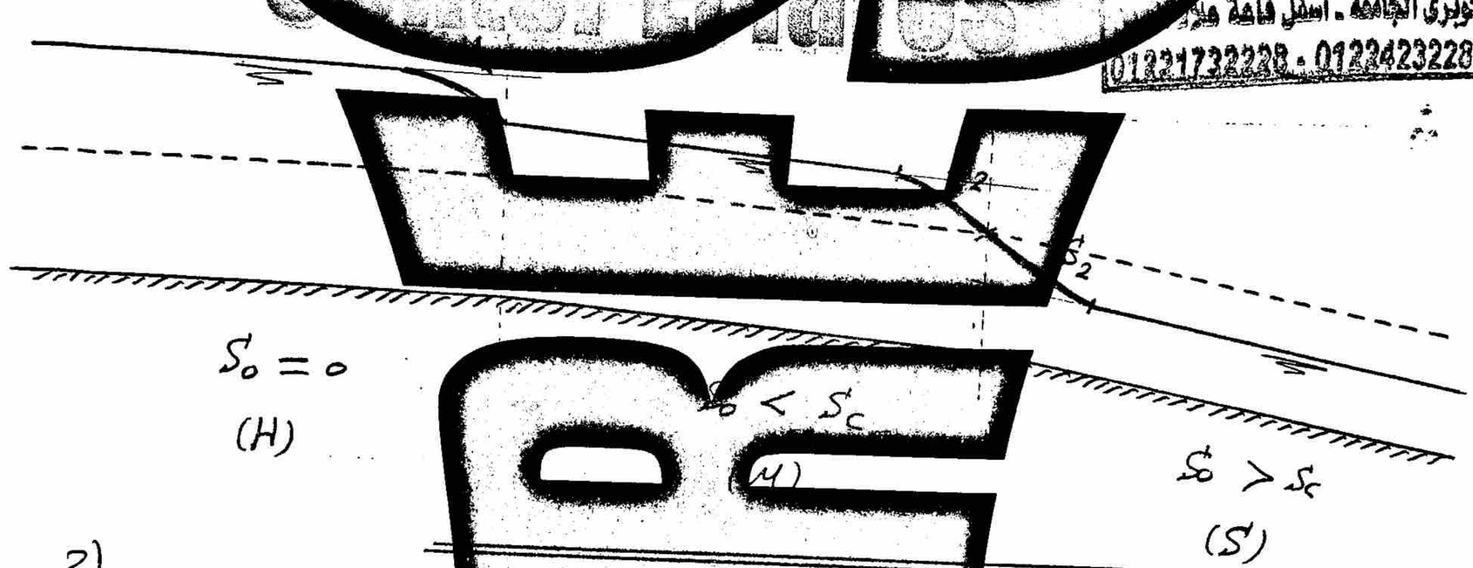


$y_n > y_c$
$F < 1$
mild

$S_o > S_c$
$y_n < y_c$
$F > 1$
st

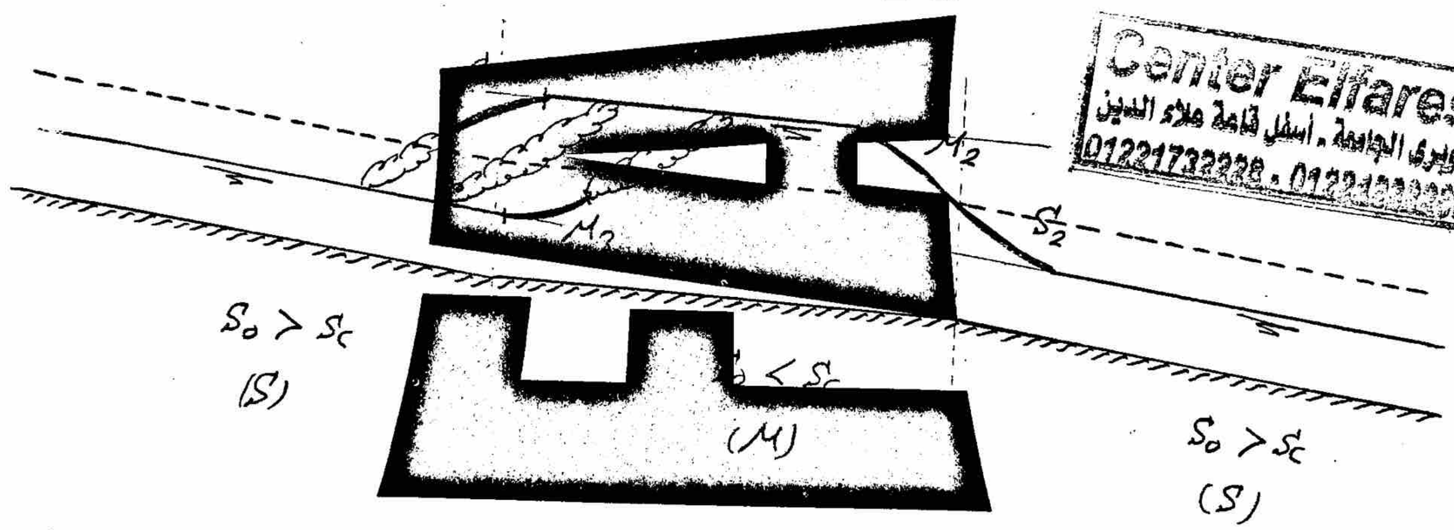
$S_o < S_c$
$y_n > y_c$
$F < 1$

2)



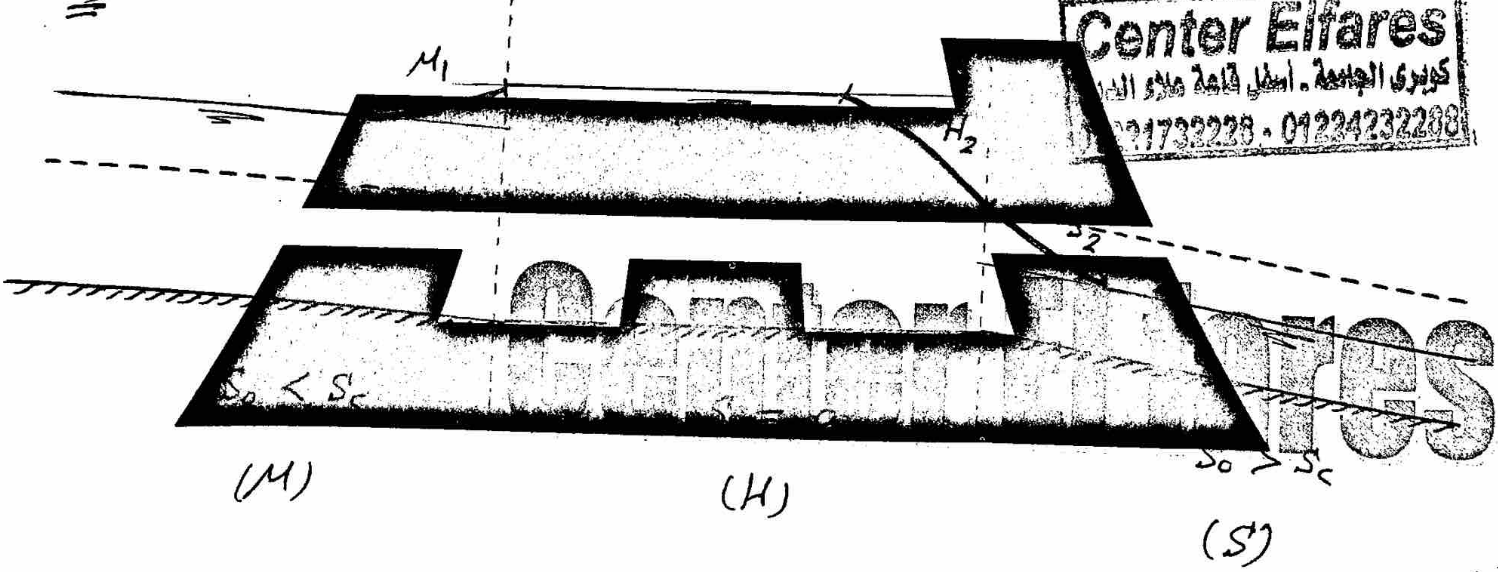
2
S_2
$S_o = o$
(H)
$S_o < S_c$
(M)
$S_o > S_c$
(S)

3)



M_2
S_2
M_3
$S_o > S_c$
(S)
$S_o < S_c$
(M)
$S_o > S_c$
(S)

4)



M_1
H_2
S_2
$S_o < S_c$
(M)
$S_o = o$
(H)
$S_o > S_c$
(S)

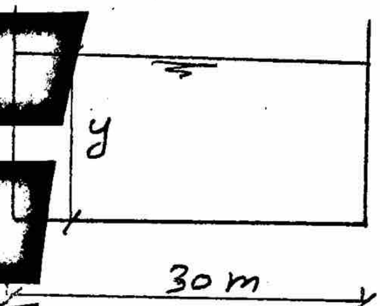
Final "2015"

A dam … across … rectangular ca… bed w…, the bed slope was 12 cm/k… (n = 0.015), the canal discharge was 15000 m³/min; the water depth upstream side … dam was expected to reach … required to,

iii- Name the water profile upstream side of the dam by l… numbers,

iv- Calculate the length of back water profile created by the dam using direct step method

$b = 30\ m$



$S_o = 12\ cm/Km$

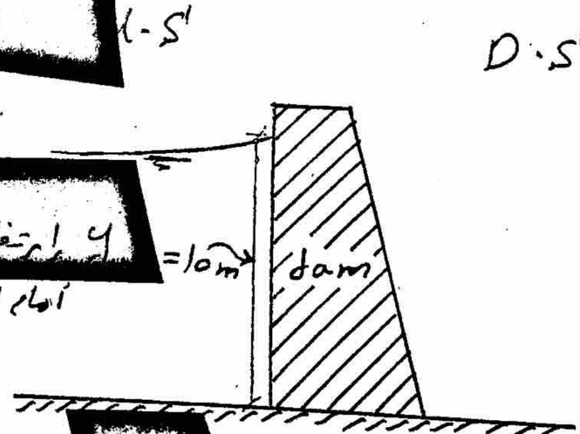
$= 0.0002$

$n = 0.015$

$Q = 15000\ m^3/min$

$= \frac{15000}{60}$

$= 250\ m^3/sec$



$y_{u.s} = 10\ m$

req:-

1) Name the water profile U.S side of the Dam

2) Length of back water profile

$S_o = 0.00012 > 0$

⇐ هناك ثلاث احتمالات من ميل القاع M, C, S

⇐ لتحديد نوع الميل يتم إيجاد قيمة y_n و y_c أو F

$$A = b \cdot y = 30y$$

$$P = b + 2y = 30 + 2y$$

$$Q = \frac{1}{n} * \frac{A^{\frac{5}{3}}}{P^{\frac{2}{3}}} * S^{\frac{1}{2}}$$

$$250 = \frac{1}{0.015} * \frac{(30y)^{\frac{5}{3}}}{(30+2y)^{\frac{2}{3}}} * (0.00012)^{\frac{1}{2}}$$

by solving equ. $\Rightarrow$ $\boxed{y_n = 4.8\ m}$

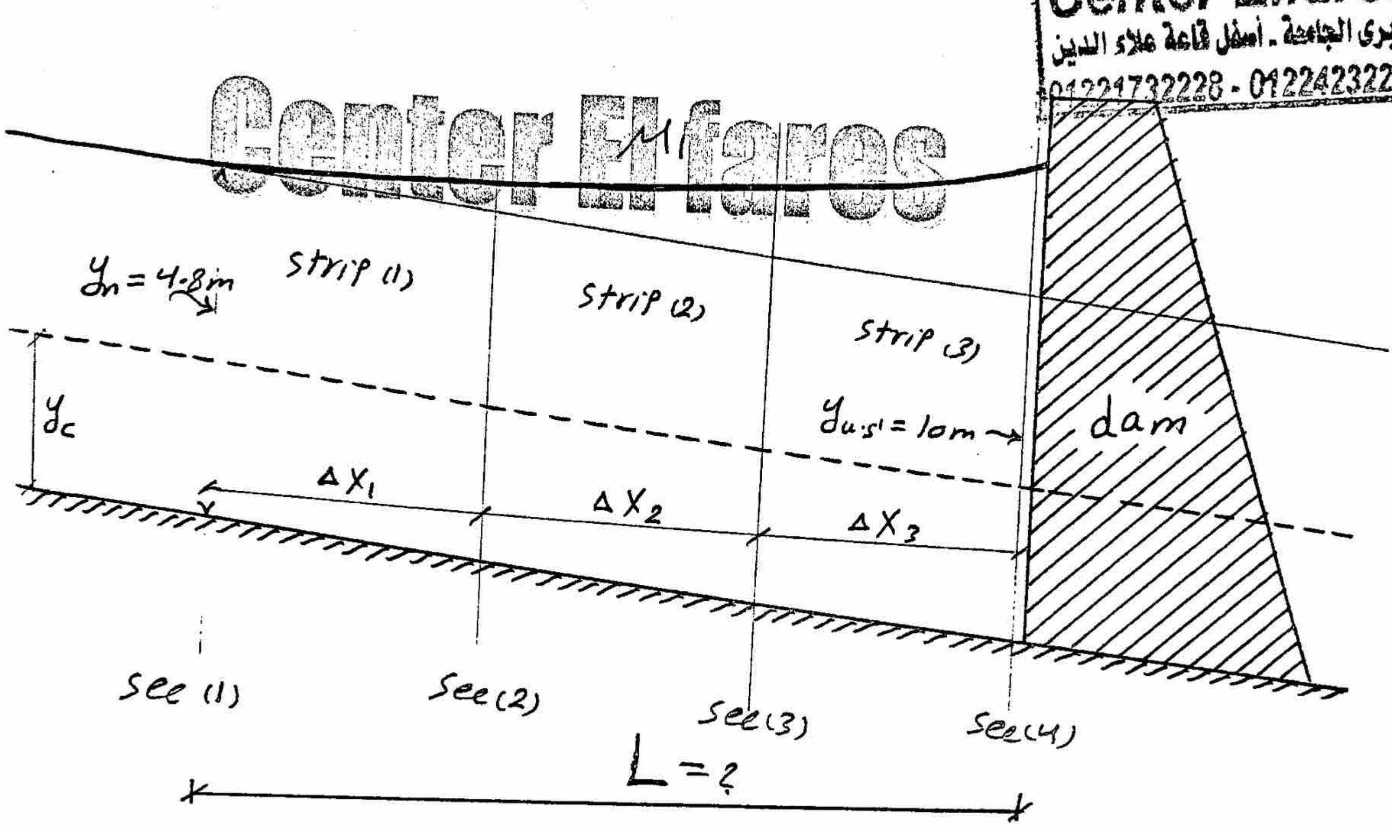
$$q = \frac{Q}{b} = \frac{250}{30} = 8.33\ m^3/sec/m$$

$$y_c = \sqrt[3]{\frac{q^2}{g}} = \sqrt[3]{\frac{(8.33)^2}{9.81}} = 1.92\ m$$

$\boxed{y_c = 1.92\ m}$

$\therefore y_n > y_c$

$\therefore S_o < S_c$ $\Longrightarrow$ $\boxed{\text{MILD SLOPE}}$



$$\Delta X = \frac{\Delta E}{\Delta S} = \frac{E_2 - E_1}{S_o - S_{E_{av}}}$$

$$E = y + \frac{V^2}{2g}$$

$$S_o = 0.00012$$

$$S_{E_{av}} = \frac{S_{E_1} + S_{E_2}}{2}$$

$$S_E = \frac{n^2 \cdot V^2}{R^{4/3}}$$

$$R = \frac{A}{P}$$

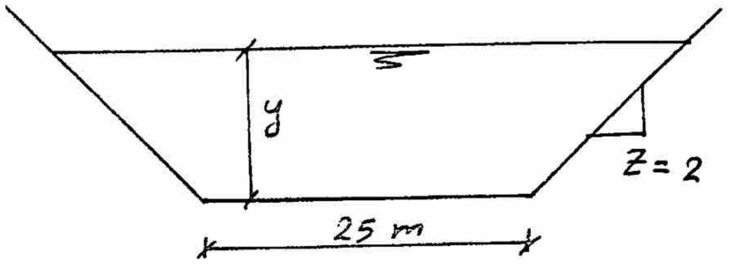
	$b \cdot y$	$\frac{Q}{A}$	$y+\frac{v^2}{2g}$	E_2-E_1	$b+2y$	$\frac{A}{P}$	$\frac{n^2 v^2}{R^{4/3}}$	$\frac{S_{E_1}+S_{E_2}}{2}$	$S_o - S_{E_{av}}$	$\frac{\Delta E}{\Delta S'}$

sec	y	A	V	E	ΔE	P	R	S_E	$S_{E_{av}}$	$\Delta S'$	ΔX
1	4.8	144	1.74	4.95		39.6	3.64	0.00012			
					1.63				0.000085	0.000035	46571
2	6.5	195	1.28	6.58		43	4.53	0.000049			
					1.67				0.000037	0.000083	20120
3	8.2	246	1.02	8.25		46.4	5.3	0.000025			
					1.79				0.00002	0.0001	17900
4	10	300	0.83	10.04		50	6	0.000014			
											84591

$L = 84591\ m$

It is required to construct a dam across a trapezoidal channel 25m wide and side slope = 2:1 and bed slope 12cm/km, n = 0.025, carrying a discharge of 250 m^3/sec. compute the back water profile created by the dam if the immediately behind the dam 7 m. the upstream end of the profile is assumed 1% greater than the normal depth.

$b = 25\ m$



$Z = 2$

$S_o = 12\ cm/km$

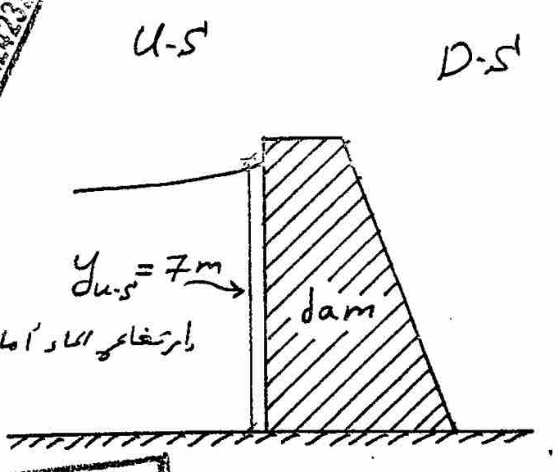
$= 0.00012$

$n = 0.025$

$Q = 250\ m^3/sec$

$y_{u\text{-}s} = 7\ m$

$y_{sec(1)} = 1.01\ y_n$



req :-

Length of back water profile

$S_o = 0.00012 > 0$

⇐ هناك ثلاث احتمالات لميل القاع كما سبق

⇐ لتحديد نوع الميل يتم إيجاد قيمة y_n , y_c او H

$$A = y(b + zy)$$

$$= y(25 + 2y) = 25y + 2y^2$$

$$P = b + 2y\sqrt{1+z^2}$$

$$= 25 + 2y\sqrt{1+(2)^2} = 25 + 4.47y$$

$$Q = \frac{1}{n} * \frac{A^{\frac{5}{3}}}{P^{\frac{2}{3}}} * S^{\frac{1}{2}}$$

$$250 = \frac{1}{0.025} * \frac{(25y + 2y^2)^{\frac{5}{3}}}{(25 + 4.47y)^{\frac{2}{3}}} * (0.00012)^{\frac{1}{2}}$$

by solving equ. $\Longrightarrow$ $\boxed{y_n = 5.9 \ m}$

$$A = 25y + 2y^2 = 25 * 5.9 + 2 * (5.9)^2$$

$$= 217 \ m^2$$

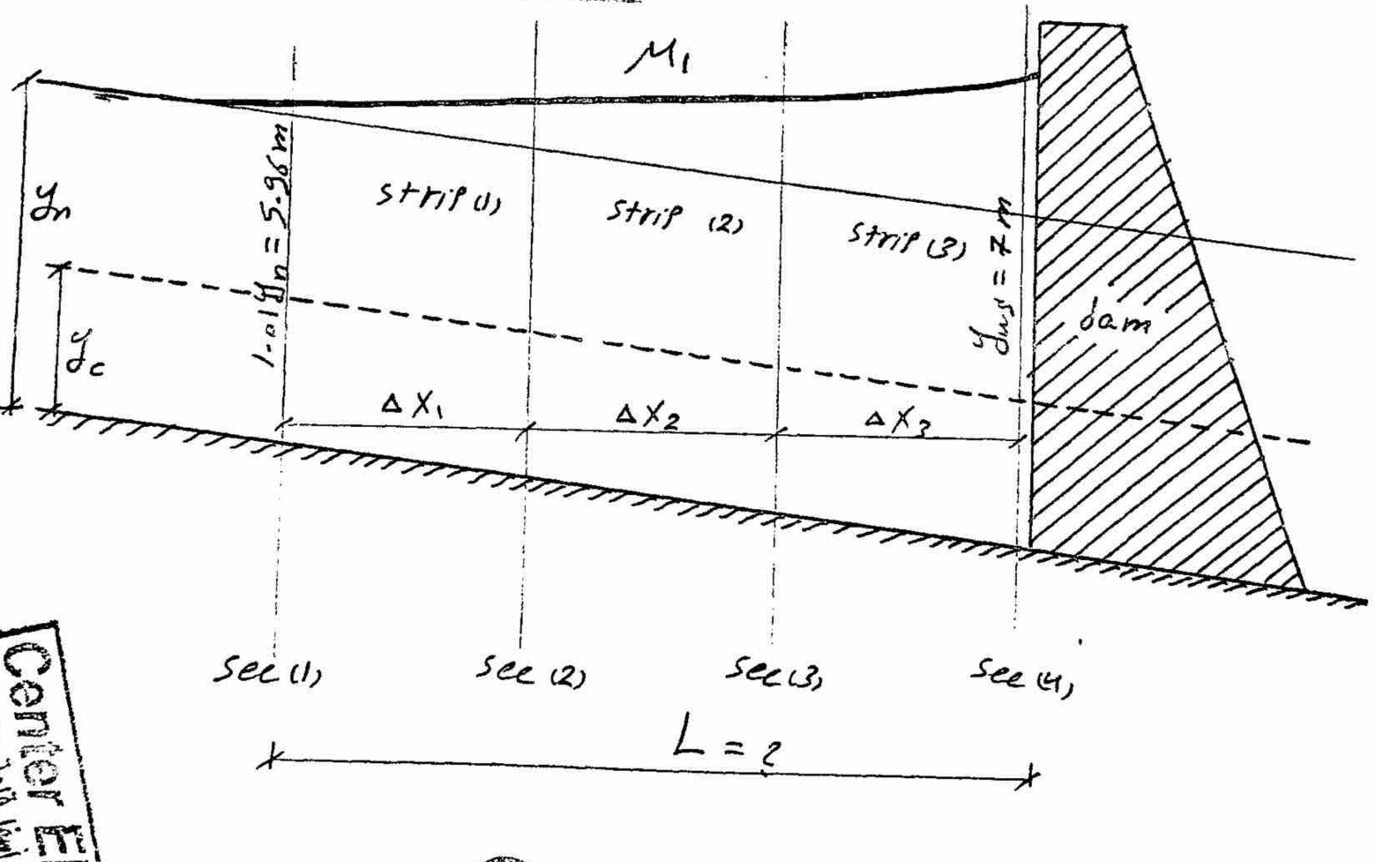
$$T = b + 2zy = 25 + 2 * 2 * 5.9 = 48.6 \ m$$

$$y_h = \frac{A}{T} = \frac{217}{48.6} = 4.47 \text{ m}$$

$$V = \frac{Q}{A} = \frac{250}{217} = 1.15 \text{ m/sec}$$

$$F = \frac{V}{\sqrt{g\, y_h}} = \frac{1.15}{\sqrt{9.81 * 4.47}} = 0.17 < 1$$

Mild slope



$$\Delta X = \frac{\Delta E}{\Delta S} = \frac{E_2 - E_1}{S_o - S_{E_{av}}}$$

	$25y+2y^2$	$\frac{Q}{A}$	$y+\frac{V^2}{2g}$	E_2-E_1	$25+4.47y$	$\frac{A}{P}$	$\frac{n^2V^2}{R^{4/3}}$	$\frac{S_{E_1}+S_{E_2}}{2}$	$S_o-S_{E_{av}}$	$\frac{\Delta E}{\Delta S}$	
sec	y	A	V	E	ΔE	P	R	S_E	$S_{E_{av}}$	ΔS	ΔX
1	5.96	220	1.14	6.03		51.64	4.26	0.00012			
					0.33				0.000107	0.000013	25385
2	6.3	237	1.05	6.36		53.16	4.46	0.000094			
					0.34				0.000086	0.000034	10000
3	6.65	255	0.98	6.7		54.73	4.66	0.000077			
					0.34				0.000071	0.000049	6939
4	7	273	0.92	7.04		56.29	4.85	0.000064			

$\sum \Delta X$
42324

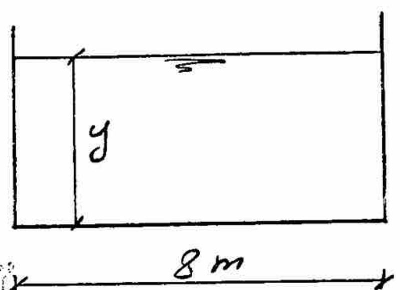
$L = 42324 \text{ m}$

A concrete rectangular lined channel of bed width = 8.0 m and bed slope of 14 cm/km carry a discharge of 36.0 m^3/s. If the sluice gate is so adjusted to produce a minimum depth of 22 cm just downstream the gate. Determine whether a hydraulic jump will form downstream the gate. Then estimate the distance from the gate to the jump, the Manning coefficient n = 0.014

$b = 8\ m$

$S_o = 14\ cm/Km$

$= 0.00014$



$Q = 36\ m^3/sec$

$n = 0.014$

req:-

1) Determine whether a hydraulic jump will form D.S the gate.

2) estimate the distance from the gate to the jump

$S_o = 0.00014 > 0$

← هناك ثلاث احتمالات لميل القاع M, C, S

← لتحديد نوع الميل يتم حساب y_n, y_c

$$A = b \cdot y = 8y$$

$$P = b + 2y = 8 + 2y$$

$$Q = \frac{1}{n} * \frac{A^{5/3}}{P^{2/3}} * S^{1/2}$$

$$36 = \frac{1}{0.014} * \frac{(8y)^{5/3}}{(8+2y)^{2/3}} * (0.00014)^{1/2}$$

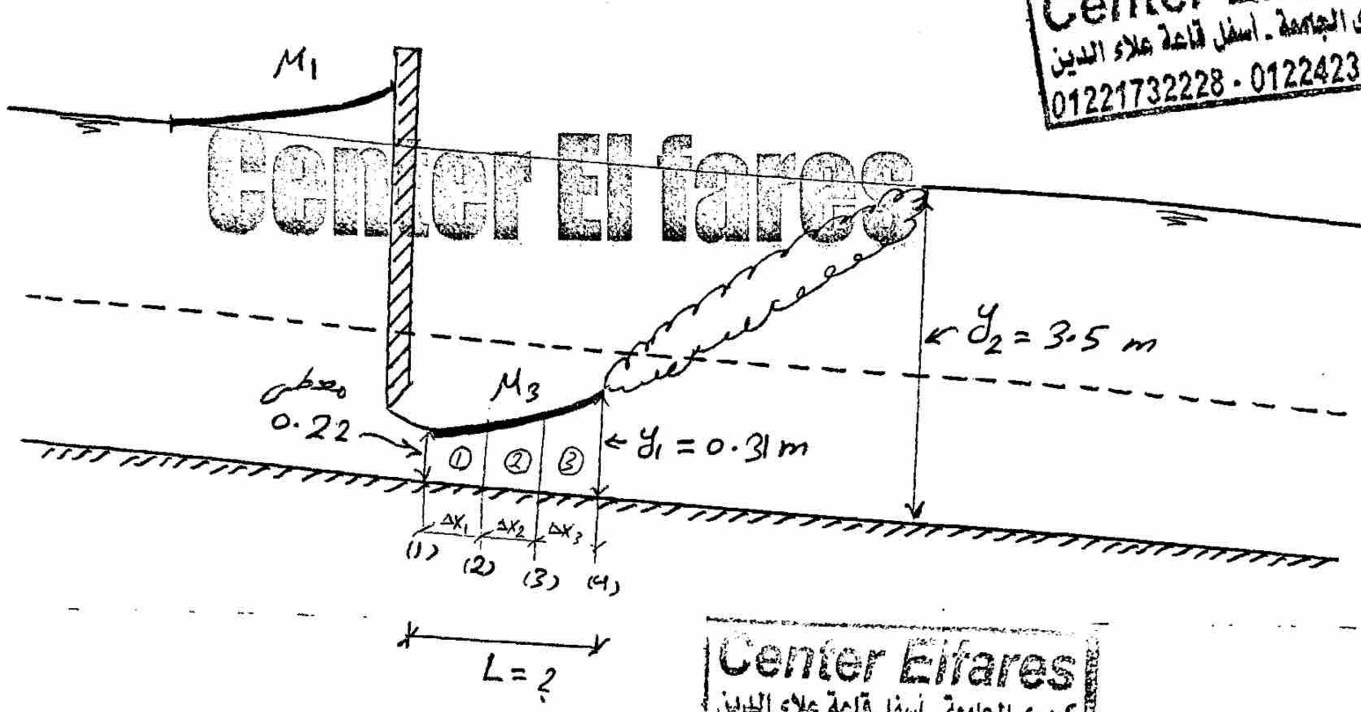
by solving eqn. $\Rightarrow$ $\boxed{y_n = 3.5 \ m}$

$$q = \frac{Q}{A} = \frac{36}{8*3.5} = 1.286 \ m^3/sec/m$$

$$y_c = \sqrt[3]{\frac{q^2}{g}} = \sqrt{\frac{(1.286)^2}{9.81}} = 0.55 \ m$$

$$y_n > y_c$$

$S_o < S_c \Rightarrow$ Mild slope



<u>to get $y_1 = ?$</u>

$$V_2 = \frac{Q}{A_2} = \frac{36}{8 * 3.5} = 1.286 \text{ m/sec}$$

$$F_2 = \frac{V_2}{\sqrt{g\,y_2}} = \frac{1.286}{\sqrt{9.81 * 3.5}} = 0.22$$

$$\frac{y_1}{y_2} = 0.5 * \left(\sqrt{1 + 8 F_2^2} - 1\right)$$

$$\frac{y_1}{3.5} = 0.5 * \left(\sqrt{1 + 8 * (0.22)^2} - 1\right)$$

$$y_1 = 0.31 m$$

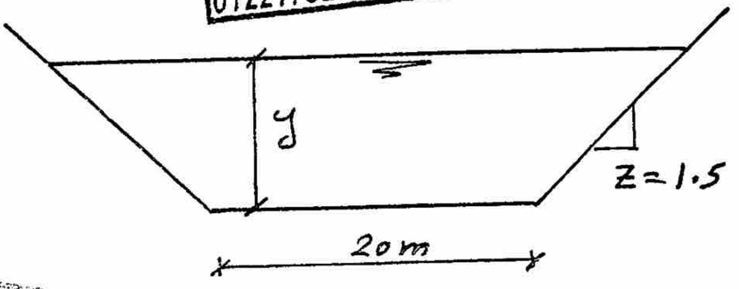
$$\Delta X = \frac{\Delta E}{\Delta S}$$

	$b\cdot y$	$\frac{Q}{A}$	$y+\frac{V^2}{2g}$	E_2-E_1	$b+2y$	$\frac{A}{P}$	$\frac{n^2V^2}{R^{4/3}}$	$\frac{S_{E_1}+S_{E_2}}{2}$	$S_0-S_{E_{av}}$	$\frac{\Delta E}{\Delta S}$
sec	y	A	V	E	ΔE	P	R	S_E	$S_{E_{av}}$	ΔS	ΔX
1	0.22	1.76	20.5	21.64		8.44	0.21	0.66			
					4.88				0.549	0.54886	8.9
2	0.25	2.0	18	16.76		8.5	0.235	0.438			
					3.27				0.3705	0.37036	8.8
3	0.28	2.24	16.1	13.49		8.56	0.262	0.303			
					2.46				0.26	0.25986	9.5
4	0.31	2.48	14.5	11.03		8.62	0.288	0.217			
											27.2

$L = 27.2\ m$

An over flow weir is constructed across a trapezoidal channel of bed width = 20 m side slopes = 3:2, bed slope = 0.009. the water level just up-stream the weir is raised to 4.50 m, when the discharge is 450 m^3/sec. classify the water surface profile created by the weir and calculate the floor length on which gradually varied flow occur, n = 0.025.

$b = 20\ m$

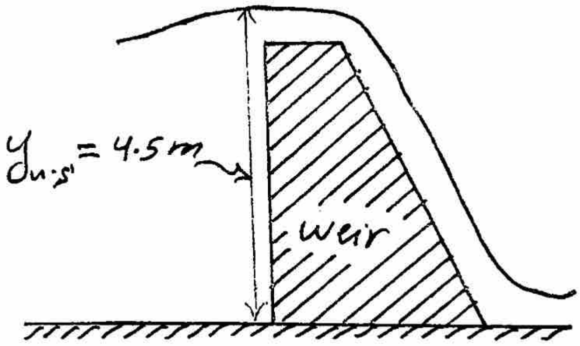


$Z = 1.5$

$S_o = 0.009$

$y_{u.s} = 4.5\ m$

$Q = 450\ m^3/sec$



$n = 0.025$

req :-

1) Classify the water surface profile

2) Length of back water profile

$S_o = 0.009 > 0$

⇐ هناك ثلاث احتمالات على العمق

⇐ للتحديد وسلوك يتم إيجاد y_n و y_c أو F

$$A = y(b + zy)$$

$$= y(20 + 1.5y) = 20y + 1.5y^2$$

$$P = b + 2y\sqrt{1 + z^2}$$

$$= 20 + 2y\sqrt{1 + (1.5)^2} = 20 + 3.6y$$

$$Q = \frac{1}{n} * \frac{A^{5/3}}{P^{2/3}} * S^{1/2}$$

$$450 = \frac{1}{0.025} * \frac{(20y + 1.5y^2)^{5/3}}{(20 + 3.6y)^{2/3}} * (0.009)^{1/2}$$

by solving equ $\Rightarrow$ $y_n = 2.83\ m$

$$A = 20 * 2.83 + 1.5 * (2.83)^2 = 68.61\ m^2$$

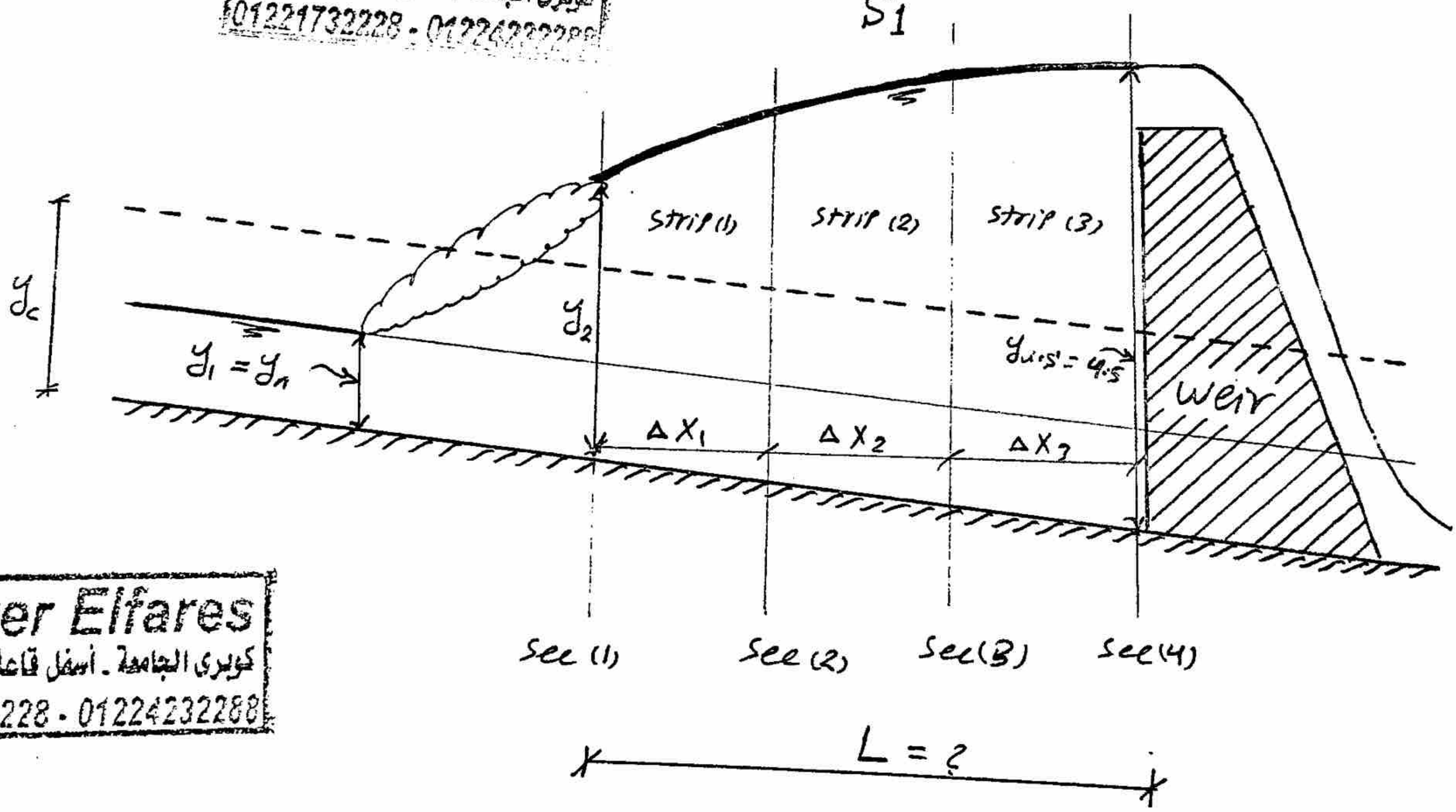
$$T = b + 2zy = 20 + 2 * 1.5 * 2.83 = 28.49\ m$$

$$y_h = \frac{A}{T} = \frac{68.61}{28.49} = 2.41$$

$$V = \frac{Q}{A} = \frac{450}{68.61} = 6.6 \text{ m/sec}$$

$$F = \frac{V}{\sqrt{g \cdot y_h}} = \frac{6.6}{\sqrt{9.81 * 2.41}} = 1.36 > 1$$

steep slope



$$\Delta X = \frac{\Delta E}{\Delta S} = \frac{E_2 - E_1}{S_o - S_{E_{av}}}$$

⇐ يتم إيجاد قيمة y_2 باستخدام المعادلة العامة لإتزان الـ Hydraulic jump

$$A_1 \bar{y}_1 + \frac{Q^2}{g A_1} = A_2 \bar{y}_2 + \frac{Q^2}{g A_2}$$

$$\boxed{A \bar{y} = \frac{b y^2}{2} + \frac{z y^3}{3}}$$

$$\frac{20 * (2.83)^2}{2} + \frac{1.5 * (2.83)^3}{3} + \frac{(450)^2}{9.81 * 68.61} =$$

$$\frac{20 * y_2^2}{2} + \frac{1.5 * y_2^3}{3} + \frac{(450)^2}{9.81 * y_2 (20 + 1.5 y_2)}$$

$$392.3 = 10 y_2^2 + 0.5 y_2^3 + \frac{20642}{y_2 (20 + 1.5 y_2)}$$

by solving equ.

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$y_2 = -18.5$ ✗ , $y_2 = 2.83$ ✗ , $y_2 = 4.04$ ✓

take $y_2 = 4.04 \, m$

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see	y	A	V	E	ΔE	P	R	S_E	$S_{E_{av}}$	ΔS	ΔX
		$20y+1.5y^2$	$\frac{Q}{A}$	$y+\frac{v^2}{2g}$	E_2-E_1	$20+3.6y$	$\frac{A}{P}$	$\frac{n^2v^2}{R^{4/3}}$	$\frac{S_{E_1}+S_{E_2}}{2}$	$S_o-S_{E_{av}}$	$\frac{\Delta E}{\Delta S}$
1	4.04	105.3	4.27	4.97		34.5	3.05	0.00258			
					0.07				0.00241	0.00659	10.62
2	4.2	110.5	4.07	5.04		35.12	3.15	0.00224			
					0.09				0.00211	0.00689	13.06
3	4.35	115.4	3.9	5.13		35.66	3.24	0.00198			
					0.08				0.00187	0.00713	11.22
4	4.5	120.4	3.74	5.21		36.2	3.33	0.00176			
											34.9

$L = 34.9\ m$

sec	y	A	V	E	ΔE	P	R	S_E	$S_{E_{av}}$	ΔS	ΔX
		$20y+1.5y^2$	$\frac{Q}{A}$	$y+\frac{V^2}{2g}$	E_2-E_1	$20+3.6y$	$\frac{A}{P}$	$\frac{n^2V^2}{R^{4/3}}$	$\frac{S_{E_1}+S_{E_2}}{2}$	$S_o-S_{E_{av}}$	$\frac{\Delta E}{\Delta S}$
1	4.04	105.3	4.27	4.97		34.5	3.05	0.00258			
					0.07				0.00241	0.00659	10.62
2	4.2	110.5	4.07	5.04		35.12	3.15	0.00224			
					0.09				0.00211	0.00689	13.06
3	4.35	115.4	3.9	5.13		35.66	3.24	0.00198			
					0.08				0.00187	0.00713	11.22
4	4.5	120.4	3.74	5.21		36.2	3.33	0.00176			
											34.9

$L = 34.9\ m$

- Spillway of a dam is constructed over a horizontal R.C floor of width of 50 m to pass a discharge of 200 m^3/s. the velocity of water at the D.S. leg of the spillway is 10 m/s, water below the apron is 2.50 m, (n = 0.016).

Determine

a) How long the apron should be built?

b) The energy loss from the foot of the spillway to the downstream side of the jump.

$b = 50\ m$

$Q = 200\ m^3/sec$

$V_{D.S} = 10\ m/sec$

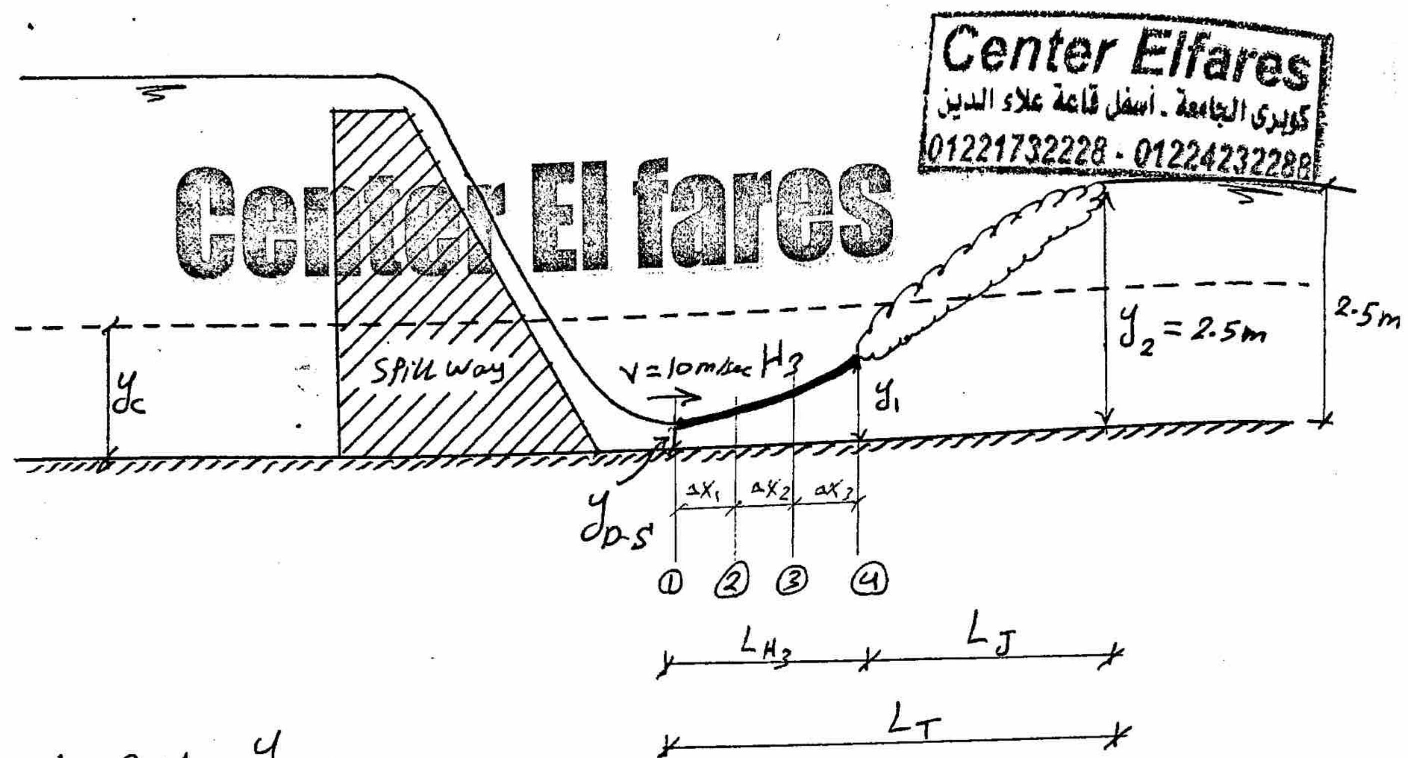
$y_n = 2.5\ m$

$n = 0.016$

req :-

a) $L_T = ?$

b) $h_L = ?$



⇒ to get y_{D-S}

$$Q = A \cdot V$$

$$200 = 50 * y_{D-S} * 10 \Rightarrow y_{D-S} = 0.4\ m$$

⇒ to get y_1

$$V_2 = \frac{Q}{A_2} = \frac{200}{50 * 2.5} = 1.6\ m/sec$$

$$F_2 = \frac{V_2}{\sqrt{g\, y_2}} = \frac{1.6}{\sqrt{9.81 * 2.5}} = 0.323$$

$$\frac{y_1}{y_2} = 0.5\left(\sqrt{1 + 8 F_2^2} - 1\right)$$

$$\frac{y_1}{2.5} = 0.5\left(\sqrt{1 + 8 * (0.323)^2} - 1\right)$$

$$\boxed{y_1 = 0.44\ m}$$

a) $L_T = L_{H_3} + L_j$

$= L_{H_3} + 5.2\, y_2$

من الجدول $= 11.19 + 5.2 * 2.5$

$= 24.19 \ m$

b)

$h_{L_T} = E_{D\text{-}s'} - E_2$

$= \left(y_{D\text{-}s'} + \frac{V_{D\text{-}s'}^2}{2g}\right) - \left(y_2 + \frac{V_2^2}{2g}\right)$

$= \left(0.4 + \frac{(10)^2}{2 * 9.81}\right) - \left(2.5 + \frac{(1.6)^2}{2 * 9.81}\right)$

$h_{L_T} = 2.87 \ m$

$S_o - S_{E_{av}}$

Sec	y	A	V	E	ΔE	P	R	S_E	$S_{E_{av}}$	ΔS	ΔX
1	0.4	20	10	5.5		50.8	0.394	0.08863			
					0.3				0.0843	0.0843	3.56
2	0.413	20.65	9.69	5.2		50.826	0.406	0.08			
					0.28				0.076	0.076	3.68
3	0.426	21.3	9.39	4.92		50.852	0.419	0.072			
					0.27				0.0684	0.0684	3.95
4	0.44	22	9.09	4.65		50.88	0.432	0.0648			
											11.19

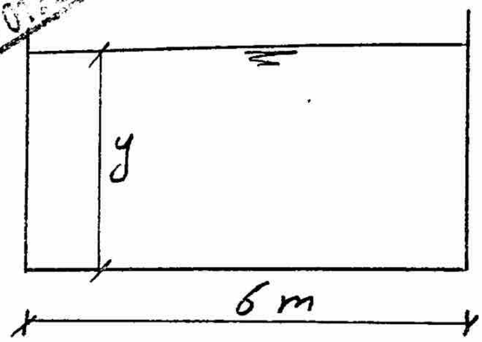
$L_{H_3} = 11.19\ m$

- A long rectangular channel of 6.0 m width carries a discharge of $25 m^3/sec$, bed slope = 0.05, n = 0.025. At a certain section the channel bed slope is changed to 0.0003 determine.

1) The length of the channel through which the flow is non uniform.

2) The power lost through the jump.

$b = 6 \ m$

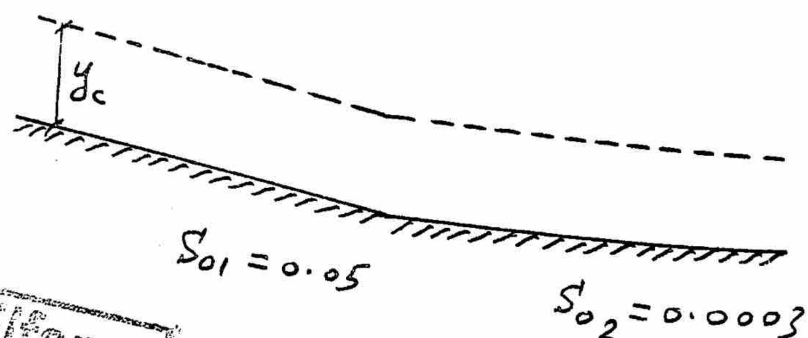


$Q = 25 \ m^3/sec$

$S_{o_1} = 0.05$

$S_{o_2} = 0.0003$

$n = 0.025$



req :-

1) Length

2) Power Lost through the jump

⇐ هناك ثلاث إحتمالات للميول M, C, S

⇐ يتم حساب y_{n_1}, y_{n_2}, y_c لتحديد نوع الميل

$\Rightarrow \underline{y_c}$

$$q = \frac{Q}{b} = \frac{25}{6} = 4.17 \ m^3/sec/m$$

$$y_c = \sqrt[3]{\frac{q^2}{g}} = \sqrt[3]{\frac{(4.17)^2}{9.81}} = 1.21 \ m$$

$\Rightarrow \underline{S_{o_1} = 0.05} \quad \Rightarrow y_{n_1} = ?$

$$A = b \cdot y = 6y$$

$$P = b + 2y = 6 + 2y$$

$$Q = \frac{1}{n} * \frac{A^{5/3}}{P^{2/3}} * S^{1/2}$$

$$25 = \frac{1}{0.025} * \frac{(6y)^{5/3}}{(6+2y)^{2/3}} * (0.05)^{1/2}$$

by solving equ. $\Longrightarrow y_{n_1} = 0.7 \ m < y_c$

steep slope

$\Rightarrow \underline{\underline{S_{o_2} = 0.0003}} \Rightarrow y_{n_2} = ?$

$A = 6y$

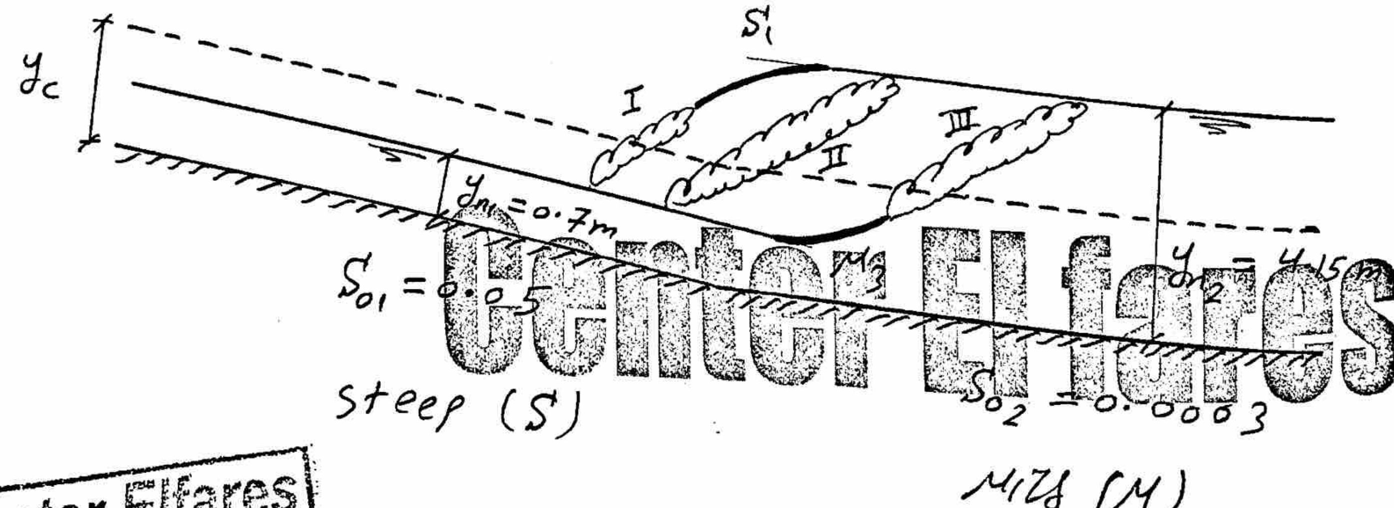
$P = 6 + 2y$

$$Q = \frac{1}{n} * \frac{A^{\frac{5}{3}}}{P^{\frac{2}{3}}} * S^{\frac{1}{2}}$$

$$25 = \frac{1}{0.025} * \frac{(6y)^{\frac{5}{3}}}{(6+2y)^{\frac{2}{3}}} * (0.0003)^{\frac{1}{2}}$$

by solving equ. $\Rightarrow$ $y_{n_2} = 4.15\,m > y_c$

Mild slope



≪ هناك ثلاث احتمالات للانتقال ولتحديد أي احتمال سوف يحدث

نفرض أن $y_1 = y_{n1}$ ونحسب y_2 للـ Jump ونقارنها بـ y_{n2}

$y_2 < 4.15 \Rightarrow \mathrm{I}$

$y_2 = 4.15 \Rightarrow \mathrm{II}$

$y_2 > 4.15 \Rightarrow \mathrm{III}$

$$V_1 = \frac{Q}{A_1} = \frac{25}{6 * 0.7} = 5.95 \ m/sec$$

$$F_1 = \frac{V_1}{\sqrt{g y_1}} = \frac{5.95}{\sqrt{9.81 * 0.7}} = 2.27$$

$$\frac{y_2}{y_1} = 0.5 \left(\sqrt{1 + 8 F_1^2} - 1 \right)$$

$$\frac{y_2}{0.7} = 0.5 \left(\sqrt{1 + 8 * (2.27)^2} - 1 \right)$$

$y_2 = 1.92 \ m < 4.15$

Case I

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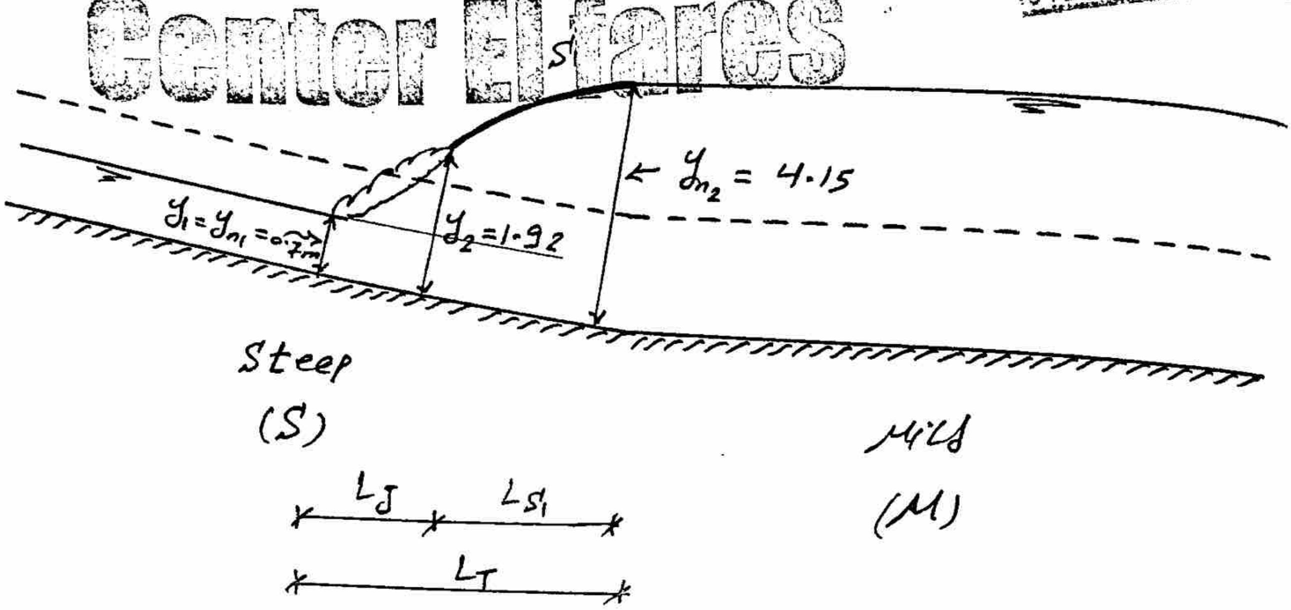
Case (I)



$$L_T = L_J + L_{S_1}$$

$$= 5 * (y_2 - y_1) + L_{S_1}$$

من الجدول

$$= 5 * (1.92 - 0.7) + 41.56$$

$$L_T = 47.66 \text{ m}$$

$$h_L = \frac{(y_2 - y_1)^3}{4 y_1 y_2} = \frac{(1.92 - 0.7)^3}{4 * 0.7 * 1.92} = 0.34 \text{ m}$$

$$Power = \frac{\gamma \cdot Q \cdot h_L}{75} = \frac{1000 * 25 * 0.34}{75} = 113 \text{ hp}$$

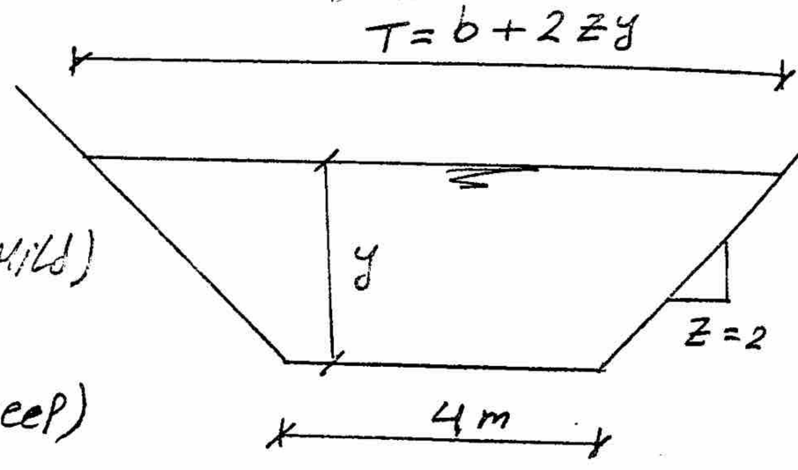
sec	y	A	V	E	ΔE	P	R	S_E	$S_{E_{av}}$	ΔS	ΔX
		$b \cdot y$	$\frac{Q}{A}$	$y+\frac{v^2}{2g}$	$E_2 - E_1$	$b+2y$	$\frac{A}{P}$	$\frac{n^2 \cdot v^2}{R^{4/3}}$	$\frac{S_{E_1}+S_{E_2}}{2}$	$S_o - S_{E_{av}}$	$\frac{\Delta E}{\Delta S}$
1	1.92	11.52	2.17	2.16		9.84	1.17	0.00239			
					0.63				0.00168	0.04832	13.04
2	2.66	15.96	1.57	2.79		11.32	1.41	0.00097			
					0.69				0.00074	0.04926	14
3	3.4	20.4	1.23	3.48		12.8	1.59	0.00051			
					0.72				0.00041	0.04959	14.52
4	4.15	24.9	1.004	4.2		14.3	1.74	0.0003			
											41.56

$L_{s_1} = 41.56\ m$

An open channel of trapezoidal section of bed width 4.0m and side slope 2:1 the canal consists of three successive reaches the first reach is of mild bed slope (S_o = 0.0003188), the second one is of steep slope (S_o = 0.0921), and the last one is of mild slope (S_o = 0.0011262), n = 0.025, if the water depth at the control section is 2.0 m it is required to,

1- Calculate the two conjugate depths,
2- The relative initial and the relative sequent water depths,
3- The hydraulic jump energy loss, and the jump efficiency,
4- Estimate the jump length,
5- Draw the water surface profile.

$b = 4\ m$



$z = 2$

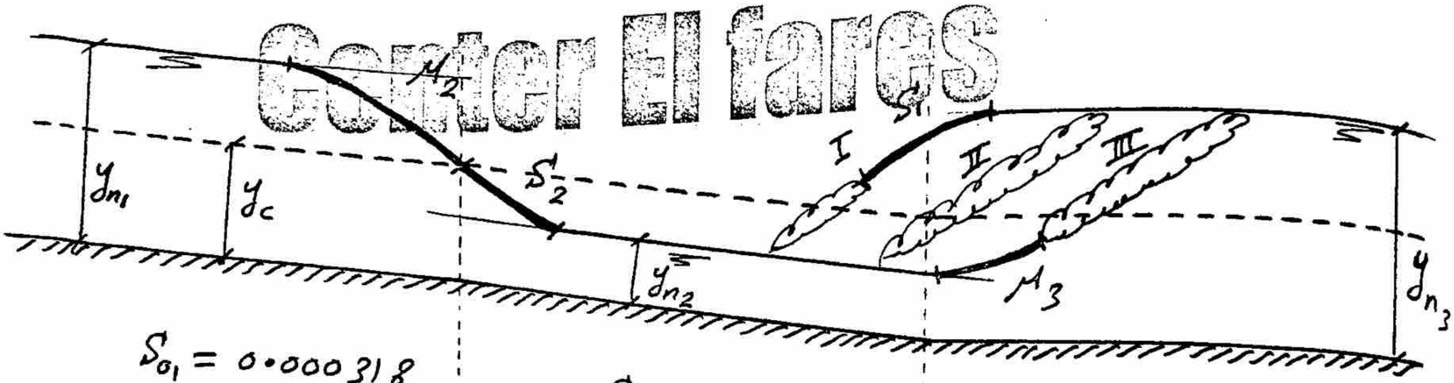
$S_{o_1} = 0.000318$ (Mild)

$S_{o_2} = 0.0921$ (steep)

$S_{o_3} = 0.0011262$ (Mild)

$n = 0.025$

$y_c = 2\ m$



$S_{o_1} = 0.000318$ Mild

$S_{o_2} = 0.0921$ steep

$S_{o_3} = 0.0011262$ Mild

⇐ يتحسب التصرف من معادله y_c لـ (non-Rec-sec)

$$A = y_c\,(b + Z y_c)$$

$$= 2\,(4 + 2*2) = 16\ m^2$$

$$T = b + 2 Z y_c$$

$$= 4 + 2*2*2 = 12\ m$$

$$\frac{Q^2}{g} = \frac{A^3}{T}$$

$$\frac{Q^2}{9.81} = \frac{(16)^3}{12} \Rightarrow Q = 57.87\ m^3/sec$$

⇐ هناك ثلاث احتمالات لانتقال الماء من الميل الثاني إلى الميل الثالث. وبالتالي يتم حساب y_{n_2} ، y_{n_3} أولاً ثم تحديد أي احتمال سوف يحدث

$\Rightarrow$ For $S_{o_2} = 0.0921 \Rightarrow y_{n_2} = ?$

$$A = y(b + zy)$$
$$= y(4 + 2y) = 4y + 2y^2$$

$$P = b + 2y\sqrt{1+z^2}$$
$$= 4 + 2y\sqrt{1+(2)^2} = 4 + 4.47y$$

$$Q = \frac{1}{n} * \frac{A^{5/3}}{P^{2/3}} * S^{1/2}$$

$$57.87 = \frac{1}{0.025} * \frac{(4y+2y^2)^{5/3}}{(4+4.47y)^{2/3}} * (0.0921)^{1/2}$$

by solving equ. $\Rightarrow$ $\boxed{y_{n_2} = 1.0 \text{ m}}$

$\Rightarrow$ For $S_{o_3} = 0.0011262 \Rightarrow y_{n_3} = ?$

$$57.87 = \frac{1}{0.025} * \frac{(4y+2y^2)^{5/3}}{(4+4.47y)^{2/3}} * (0.0011262)^{1/2}$$

by solving equ. $\Rightarrow$ $\boxed{y_{n_3} = 3.0 \text{m}}$

بفرض حدوث الاحتمال الأول

$y_1 = y_{n_2} = 1.0\,m$ ⟸

وحساب y_2 لل Jumb فاذا كانت

$y_2 < 3$ (y_{n_2}) $\Rightarrow$ Case (I)

$y_2 = 3.0 \Rightarrow$ Case (II)

$y_2 > 3.0 \Rightarrow$ Case (III)

المعادله العامه لإيجاد الـ Jumb Non-Rec-sec

$$A_1 y_1' + \frac{Q^2}{g A_1} = A_2 y_2' + \frac{Q^2}{g A_2}$$

$$A y' = \frac{b y^2}{2} + \frac{z y^3}{3}$$

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$$\frac{4*(1)^2}{2} + \frac{2*(1)^3}{3} + \frac{(57.87)^2}{9.81*(1*(4+2*1))} =$$

$$\frac{4*y_2^2}{2} + \frac{2*y_2^3}{3} + \frac{(57.87)^2}{9.81*(y_2*(4+2*y_2))}$$

by solving eqn $\Rightarrow$ $y_2 = 3.43\,m$

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$y_2 > 3 \Rightarrow$ Case III

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1) $y_2 = 3.0\,m \quad , \quad y_1 = ?$

$$A_1 \bar{y}_1 + \frac{Q^2}{g A_1} = A_2 \bar{y}_2 + \frac{Q^2}{g A_2}$$

$$\frac{4 y_1^2}{2} + \frac{2 y_1^3}{3} + \frac{(57.87)^2}{9.81 * (y_1 (4 + 2 y_1))} =$$

$$\frac{4 * (3)^2}{2} + \frac{2 * (3)^3}{3} + \frac{(57.87)^2}{9.81 * (3 (4 + 2 * 3))}$$

by solving eqn. $\rightarrow$ $y_1 = 1.23\,m$

$y_1 = 1.23\,m \quad , \quad y_2 = 3.0\,m$

---

2) $A_1 = y_1 (b + z y_1)$

$$= 1.23 (4 + 2 * 1.23) = 7.95\,m^2$$

$$V_1 = \frac{Q}{A_1} = \frac{57.87}{7.95} = 7.28\,m/sec$$

$$E_1 = y_1 + \frac{V_1^2}{2g} = 1.23 + \frac{(7.28)^2}{2 \times 9.81} = 3.93\,m$$

$$\frac{y_1}{E_1} = \frac{1.23}{3.93} = 0.31$$

$$\frac{y_2}{E_1} = \frac{3.0}{3.93} = 0.76$$

3)

$$A_2 = y_2\,(b + Z y_2)$$

$$= 3*(4+2*3) = 30\ m^2$$

$$V_2 = \frac{Q}{A_2} = \frac{57.87}{30} = 1.93\ m/sec$$

$$E_2 = y_2 + \frac{V_2^2}{2g}$$

$$= 3 + \frac{(1.93)^2}{2*9.81} = 3.2\ m$$

$$h_L = E_1 - E_2$$

$$= 3.93 - 3.2 = 0.73\ m$$

$$\eta = \frac{E_2}{E_1} = \frac{3.2}{3.93} = 0.81$$

4) $L_J = 5.2\,y_2 = 5.2*3 = 15.6\ m$

5)